SIS3820
VME Scaler

User Manual

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Revision Table:

Revision	Date	Modification
0.0x	13.02.02	Start of module definition
0.10	23.06.03	Prerelease
1.00	24.06.03	First official release
1.01	11.08.03	Id. reg R/W -> R only bug fix in JTAG JP570 text and watchdog enable
1.10	09.12.03	VME JTAG firmware upgrade support, read during preset scaler operation, support for 512 MB memory strips and add mode (Xilinx Firmware: sis38200102.mcs)
1.20	27.04.04	Firmware Version 01 03 Chained Block Transfer (CBLT) implemented (Xilinx Firmware: sis38200103.mcs)
1.30	04.06.04	Firmware Version 01 04 48-bit deep counter implementation in channels 1 and 17 (for scaler mode, new address 0x210)
1.31	09.11.04	Bug fix in address map, change FIFO threshold register explanation
1.32	13.01.05	Couple of index entries added, typo fix
1.40	20.05.05	Firmware Version 01 05 New Control Output mode 2 (10Mhz)
1.50	26.08.05	Firmware Version 01 08 New Control Input mode 6 (with external counter clear)
1.60	14.10.05	Firmware Version 01 09 Bug fix in control input inversion New register 0x214 (veto external count inhibit)
1.61	20.10.05	Bug fix in example veto external count register
1.70	03.11.05	Firmware Version 01 0A New register 0x218 (test pulse mask register)
1.71	04.12.05	Bug fixes
1.72	11.02.06	ESD note added
1.80	15.06.06	New MUX_OUT feature, firmware revision 0xB
1.81	19.06.06	Bug fixes
1.82	25.10.06	Note on external LNE/channel N rate being limited to 5 MHz
1.83	21.11.06	JTAG jumper JP570 factory default
1.84	27.07.07	50 Ω TTL and high impedance input configuration
1.85	05.02.09	Add missing Key address texts in address map Bug fix in MCS example text
1.86	07.02.09	Add short explanation for key addresses
1.87	14.05.09	New Encoder feature to generate LNEs, Firmware revision 0xD LNE timing added
2.00	27.07.11	Support for 13 row 11 column 512 MB SDRAM strip Firmware version 0xE

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2 Introduction

The SIS3820 is a multi purpose counter. It combines the functionality of the SIS3800 scaler and the SIS3801 multiscaler with extended functions. The proven concept of flexible leaded component based frontend circuitry in conjunction with more recent FPGA (field programmable gate array) technology results in unprecedented flexibility to implement the given readout application.

Applications comprise, but are not limited to:

- Nuclear Phyics
- Particle Physics
- Neutrino/Astrophysics
- Synchrotron Radiation
- Neutron Scattering
- Machine (accelerator) diagnosis
- Scanning microscope readout

3 Technical Properties/Features

This manual describes the implemented functionality for the SIS3820-SCALER firmware. Other firmware designs are SIS3820-CLOCK (clock distributor for up to 32 SIS330x VE digitizers) and SIS3820-LATCH (input register with counter and interrupt functionality)

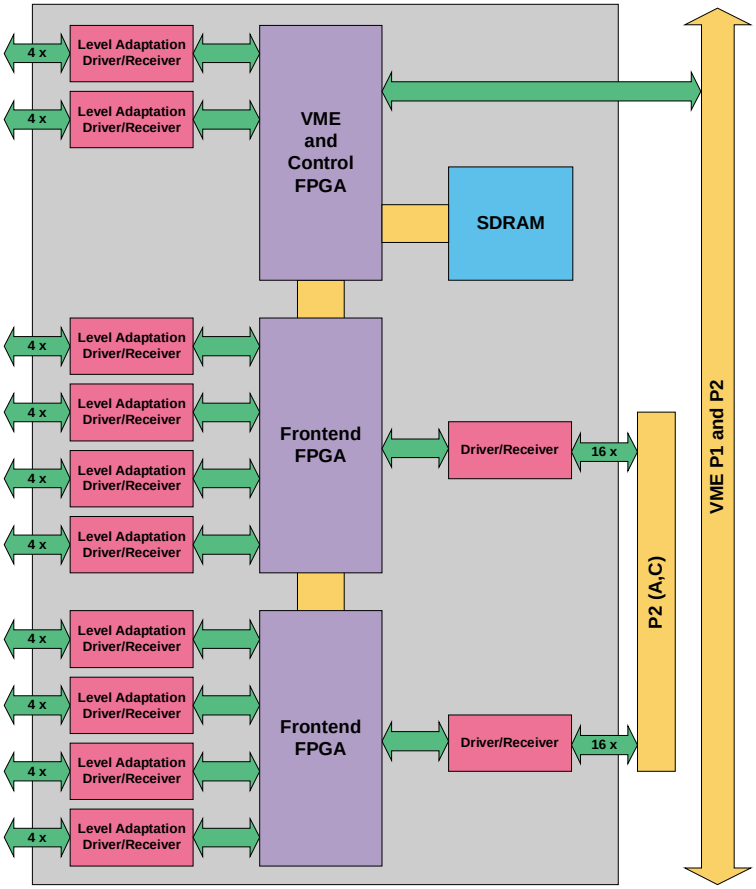
Find below a list of key features of the SIS3820.

- 32 channels (64 channel option)
- 4 front panel control inputs
- 4 front panel control outputs
- 64 Mbytes SDRAM (512 MB option)
- 250 MHz counting rate (ECL and NIM), 100 MHz for TTL (50 MHz for P2 fed channels)
- 32-bit counter depth (channel 1 and 17 48-bit deep with firmware > 01 04 in scaler mode)
- NIM/TTL/ECL/LVDS versions
- flat cable (ECL, TTL and LVDS) and LEMO (TTL/NIM) options
- multi channel, latching and preset scaler operation
- shadow register (latching scaler mode)
- read on the fly (latching scaler mode)
- reference pulser
- test pulser
- A24/32 D32/BLT32/MBLT64/2eVME/CBLT32)
- Geographical addressing mode (in conjunction with VME64x backplane)
- Broadcast addressing
- Interrupt capabilities
- Hot swap (in conjunction with VME64x backplane)
- VME64x Connectors
- VME64x Side Shielding
- VME64x Front panel
- VME64x extractor handles (on request)
- single supply (+5 V)
- in field firmware upgrade capability

4 Functionality

The functionality of the SIS3820 is a combination of hardware (printed circuit board) design, stuffing options and firmware. The module consists of two FPGAs that hold the frontend logic and on FPGA that holds the VME interface, the SDRAM controller and the control logic functions. Logic level adaptation is handled by classic DIL components and single inline (SIL) resistor networks. The firmware is loaded from a serial PROM at power up. Both JTAG and VME can be used for in field firmware upgrades/changes.

4.1 Block Diagram



4.2 Modes of operation

4.2.1 Scaler/Counter

In standard counter/scaler mode data can be read on the fly with an accuracy to the least significant bit. No counts are lost in read on the fly mode.

4.2.2 Latching Scaler

In latching scaler mode scaler values are copied to a shadow register set upon a front panel signal LNE or a VME command. Broadcast functionality is implemented for the later to allow for minimum time difference over a set of several SIS3820s without front panel cabling.

4.2.3 Preset Scaler

The SIS3820 can be operated as preset scaler. An arbitrary channel or a combination of channels can be selected as the condition for the termination of the counting process. The selection of the channel(s) is done via the preset enable mask register . The first selected channel that reaches its preset value will terminate the counting process. The actual preset values are defined though the preset value register set. The internal 25 MHz pulse generator (or a prescaled derived output) can be used as time base for measurements if its enabled for channel 1 with this channel being enabled in the preset enable mask and the desired prescale factor stored into the channel 1 preset value register. The terminating channel can be identified by the actual scaler data or the preset hit mask register if more than one preset channel is enabled.

4.2.4 Multi channel Scaler (MCS)

MCS mode allows for the buffered readout of variable or fixed lengths counting time intervals. The interval length can be defined by an internal timer as well as by an external signal, which can be prescaled also. The minimum buffer memory size of 64 MB takes the realtime burden away from the VME master even at very short time intervals (dwell times). Two factors facilitate short dwell time applications. The first is high speed VME readout of data from SDRAM in MBLT64 and 2eVME. The second is data compression with a reduction in counter depth to 16 or 8-bit. Data compression is also a good way to save VME bandwidth in lower count rate applications (with V/F converters e.g.) at longer dwell times.

4.2.5 Histogramming Scaler(3820 01 02 and higher design)

Histogramming scaler mode (MCS mode with add enabled) allows to acquire and add MCS data of several repeated scans in SDRAM without CPU interaction. The user has to make sure, that the reset to the first bin and the number of bins are issued with the accuracy that is required by the application. I.e. no number of bin/reset checking mechanism is implemented (unlike in the SIS3100-HISCAL DSP based design).

5 Getting started

This section is intended for the first time SIS3820 user. In some cases it may be good enough to use the provided header file and C examples to get acquainted to a couple of the modules functions before looking at the other sections of the manual in more detail. If you have a SIS1100/3100 PCI to VME interface under LINUX or under Win2K/XP with Visual C++ you can use the provided example code without modifications.

5.1 Installation

- Select addressing A32 or geographical address mode with J1 (factory default is A32)
- Select base address with SW3 and SW4 in non geographical addressing (the default base address setting is 0x38000000)
- turn VME crate power off
- install your SIS3820 board in the VME crate
- connect inputs
- turn VME crate power back on
- verify, that the P (power) and R (ready) LEDs are on and all other LEDs are off after the approximately 2s long power up self test cycle

5.2 LINUX example/test code

The file sis3820.tar.gz holds LINUX example programs, the sis3820.h header files and Makefiles to generate the executables.

Initial VME access test
Both the user LED and readout of the Module Id. and firmware register provide a good way to verify that proper initial communciation with the SIS3820 can be established.

5.2.1 User LED test

The program sis3820_led.c runs 30 cycles with the sequence user LED on, sleep(1), user LED off, sleep(1).

5.2.2 Readout of Module Id. and firmware revision register

The program sis3820_readmodid.c reads and displays the module identification and firmware register.

```
mki@mki:~/sis1100/sis3820> ./sis3820_readmodid
Module identification and firmware register reads: 38200102
```

5.2.3 Standard Counter

In the minimum counter application you enable the logic, have the module count for a period of time and read out the scaler values after disabling the logic.
The sis3820_counter program runs 2 counting cycles of 5 s each. During the second cycle the internal 50 MHz reference pulse generator is routed to channel 1. Sample output with a 11 MHz signal connected to scaler channel 17 is shown below.

```
mki@mki:~/sis1100/sis3820> ./sis3820_counter
SIS3820 scaler counting
gotwords 32
scaler data
ch01 00000000  ch02 00000000  ch03 00000000  ch04 00000000
ch05 00000000  ch06 00000000  ch07 00000000  ch08 00000000
ch09 00000000  ch10 00000000  ch11 00000000  ch12 00000000
ch13 00000000  ch14 00000000  ch15 00000000  ch16 00000000
ch17 03477ce7  ch18 00000000  ch19 00000000  ch20 00000000
ch21 00000000  ch22 00000000  ch23 00000000  ch24 00000000
ch25 00000000  ch26 00000000  ch27 00000000  ch28 00000000
ch29 00000000  ch30 00000000  ch31 00000000  ch32 00000000
now with reference pulser on ch1 enabled
SIS3820 scaler counting
gotwords 32
scaler data
ch01 0eedfb33  ch02 00000000  ch03 00000000  ch04 00000000
ch05 00000000  ch06 00000000  ch07 00000000  ch08 00000000
ch09 00000000  ch10 00000000  ch11 00000000  ch12 00000000
ch13 00000000  ch14 00000000  ch15 00000000  ch16 00000000
ch17 0348d70d  ch18 00000000  ch19 00000000  ch20 00000000
ch21 00000000  ch22 00000000  ch23 00000000  ch24 00000000
ch25 00000000  ch26 00000000  ch27 00000000  ch28 00000000
ch29 00000000  ch30 00000000  ch31 00000000  ch32 00000000
```

Note: The 50 MHz reference pulse generator will give you an idea on the sleep/scheduling accuracy of your LINUX system.

5.2.4 Multiscaler (MCS)

MCS mode is demonstrated with the program sis3820_mcs.c. With respect to the fact that SDRAM mode with a fixed number of acquisitions is used, its kind of a minimum approach that does not make use of the full capabilities of the SIS3820.
The example uses the internal 10 MHz LNE source, which is run through the LNE prescaler to minimize the need for external signals. The number of acquisitions is preset with the acquisition preset register. The acquisition count register is used to determine completion of the acquisition process.
Find below the output of the program for 11 LNEs (corresponding to 10 time slices) with an input rate of 11 MHz moved across scaler channel 1 to channel 4 as the MCS acquisition is going on. Note that the CLR LED is pulsed with every LNE and that the S LED is on from the enable command until the acquisition preset has been reached.

```
mki@mki:~/sis1100/sis3820> ./sis3820_mcs
MCS mode, scan 1 completed
MCS mode, scan 2 completed
MCS mode, scan 3 completed
MCS mode, scan 4 completed
MCS mode, scan 5 completed
MCS mode, scan 6 completed
MCS mode, scan 7 completed
MCS mode, scan 8 completed
MCS mode, scan 9 completed
MCS mode, scan 10 completed
gotwords 40
scaler data
scan: 001 ch01 00a7d8f7  ch02 00000000  ch03 00000000  ch04 00000000
scan: 002 ch01 00a7d8f7  ch02 00000000  ch03 00000000  ch04 00000000
scan: 003 ch01 008f5010  ch02 00000000  ch03 00000000  ch04 00000000
scan: 004 ch01 00000000  ch02 003d3c9f  ch03 00000000  ch04 00000000
scan: 005 ch01 00000000  ch02 00a7d8f7  ch03 00000000  ch04 00000000
scan: 006 ch01 00000000  ch02 002255a6  ch03 00000000  ch04 00000000
scan: 007 ch01 00000000  ch02 00000000  ch03 006ee942  ch04 00000000
scan: 008 ch01 00000000  ch02 00000000  ch03 0076e9f4  ch04 00000000
scan: 009 ch01 00000000  ch02 00000000  ch03 00000000  ch04 00438a6e
scan: 010 ch01 00000000  ch02 00000000  ch03 00000000  ch04 00a7d8f7
```

5.2.5 Preset Scaler

The sis3820_preset example illustrates preset scaling. Counter group 1 is activated for preset scaling with channel 4 selected as preset channel (channel 1 with the TESTMKI compiler flag set). A value of 0x1000000 is written to the preset value register of counter group 1 and the logic enabled afterwards. The status of the preset enable and hit register is polled until channel group 1 has reached its preset value..

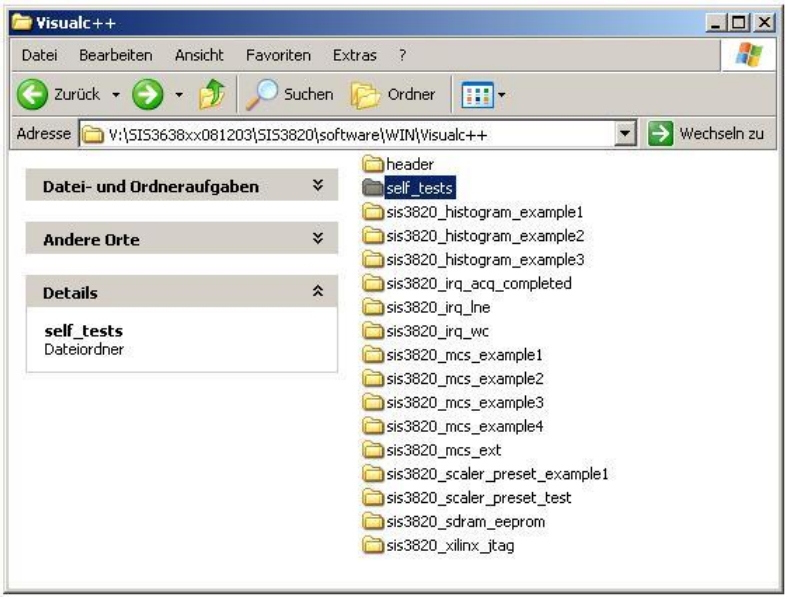
```
mki@mki:~/sis1100/sis3820> ./sis3820_preset
gotwords 32
scaler data
ch01 00000000  ch02 00000000  ch03 00000000  ch04 01000002
ch05 00000000  ch06 00000000  ch07 00000000  ch08 00000000
ch09 00000000  ch10 00000000  ch11 00000000  ch12 00000000
ch13 00000000  ch14 00000000  ch15 00000000  ch16 00000000
ch17 00000000  ch18 00000000  ch19 00000000  ch20 00000000
ch21 00000000  ch22 00000000  ch23 00000000  ch24 00000000
ch25 00000000  ch26 00000000  ch27 00000000  ch28 00000000
ch29 00000000  ch30 00000000  ch31 00000000  ch32 00000000
mki@mki:~/sis1100/sis3820>
```

Note 1: It will take in the order of 100 ns after the preset condition was detected before the counter will stop counting. This implies, that the actual stored counter value will be greater than the preset value for frequencies in excess of some 10 MHz. Above output was generated with a symmetric 15 MHz source e.g.

Note 2: The current version of `the sis3820_preset` features readout in 1s intervals in parallel to ongoing acquisition.

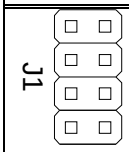
5.3 Win2K/XP Visual C++ example/test code

Find below a screen shot of the Visual C++ directory of the SIS36/38xx CDROM. A short description is given in the header section of the individual C files.



6 VME Addressing

As the SIS3820 features memory options with up 512 Mbytes of SDRAM, A32 addressing was implemented as the only option. Hence the module occupies an address space of 0xFFFFFF Bytes (i.e. 16 MBytes).
The SIS3820 firmware addressing concept is a pragmatic approach to combine standard rotary switch style settings with the use of VME64x backplane geographical addressing functionality.
The base address is defined by the selected addressing mode, which is defined by jumper array J1 and possibly SW4 and SW3 (in non geographical mode).

	Function
	EN_A32
	reserved
	EN_GEO
	SDRAM_SIZE

SDRAM_SIZE	open: 64 MBytes
	closed: 512 MBytes

EN_A32	EN_GEO	Description
0	0	non A32 addressing, reserved for future use
0	1	non A32 addressing, reserved for future use
1	0	A32 addressing, address compared with SW3/SW4
1	1	A32 addressing, address compared with geographical address
0: jumper open, 1: jumper closed		

The table below illustrates the possible base address settings.

J1 Setting	Bits							
GEO	31	30	29	28	27	26	25	24
-	SW4				SW3			
x	y	y	y	GA4	GA3	GA2	GA1	GA0

Shorthand	Explanation
SW3/SW4	Setting of rotary switch SW3 or SW4 respective
y	don't care
GA0-GA4	Geographical address bit as defined by the VME64x(P) backplane

Notes:

- This concept allows the use of the SIS3820 in standard VME as well as in VME64x environments, i.e. the user does not have to use a VME64x backplane.
- The factory default setting is 0x38000000 (i.e. SW4=3, SW3=8, EN_A32 closed and EN_GEO open/disabled)

6.1 Address map

Offset	R/W	Mode	Function/Register
0x0	R/W	D32	Control/Status register
0x4	R	D32	Module Id. and firmware revision register
0x8	R/W	D32	Interrupt configuration register
0xC	R/W	D32	Interrupt control/status register
0x10	R/W	D32	Acquisition preset register
0x14	R	D32	Acquisition count register
0x18	R/W	D32	LNE prescale factor register
0x20	R/W	D32	Preset value register counter group 1 (1 to 16)
0x24	R/W	D32	Preset value register counter group 2 (17 to 32)
0x28	R/W	D32	Preset enable and hit register
0x30	R/W	D32	CBLT/Broadcast setup register
0x34	R/W	D32	SDRAM page register
0x38	R	D32	FIFO Word count register
0x3C	R/W	D32	FIFO Word count threshold register
0x40	R/W	D32	HISCAL_START_PRESET
0x44	R	D32	HISCAL_START_COUNTER
0x48	R	D32	HISCAL_LAST_ACQ_COUNTER
0x50	R	D32	Encoder Position Counter
0x54	R	D32	Encoder Error Counter
0x100	R/W	D32	(Acquisition) Operation mode register
0x104	R/W	D32	Copy disable register
0x108	R/W	D32	LNE channel select register (1 of 32)
0x10C	R/W	D32	PRESET channel select register (2 times 1 out of 16)
0x110	R/W	D32	MUX_OUT channel select register (firmware 01 0B, 1 of 32, note 2)
0x200	R/W	D32	Inhibit/count disable register
0x204	W	D32	Counter Clear register
0x208	R/W	D32	Counter Overflow read and clear register
0x210	R	D32	Channel 1/17 Bits 33-48
0x214	R/W	D32	Veto external count inhibit register (firmware 01 09, note 2)
0x218	R/W	D32	Test pulse mask register (firmware 01 0A, note 2)
0x300	R/W		SDRAM Prom
0x310	R/W		XILINX JTAG_TEST/JTAG_DATA_IN
0x314	W		XILINX JTAG_CONTROL
future use	R/W		One wire Id. register
0x400	KA	D32 (broadcast)	Key reset
0x404	KA	D32 (broadcast)	Key SDRAM/FIFO reset
0x408	KA	D32 (broadcast)	Key test pulse
0x40C	KA	D32 (broadcast)	Key Counter Clear
0x410	KA	D32 (broadcast)	Key VME LNE/clock shadow
0x414	KA	D32 (broadcast)	Key operation arm

0x418	KA	D32 (broadcast)	Key operation enable
0x41C	KA	D32 (broadcast)	Key operation disable
0x420	KA	D32 (broadcast)	Key HISCAL_START_PULS
0x424	KA	D32 (broadcast)	Key HISCAL_ENABLE_LNE_ARM
0x428	KA	D32 (broadcast)	Key HISCAL_ENABLE_LNE_ENABLE
0x42C	KA	D32 (broadcast)	Key HISCAL_DISABLE
0x800 to 0x87C	R	D32/BLT32	Shadow registers
0xA00 to 0xA7C	R	D32/BLT32	Counter registers
0x800000 to 0xfffffc	W R	D32/BLT32 D32/BLT32/ MBLT64/2eVme	SDRAM or FIFO space array (address window for page of 8 Mbytes)

Notes:

1.) SDRAM (FIFO respective) write access with active MCS mode will result in a VME bus error. In MCS mode the memory is reserved for storage of the counter values.

2.) firmware 01 0A indicates revision 01 0A and higher unless otherwise

The shorthand KA stands for key address. Write access with arbitrary data to a key address initiates the specified function

7 Register description

The function of the individual registers is described in detail in this section.
The first line after the subsection header (in Courier font) like:

```
#define SIS3820_CONTROL_STATUS      0x0     /* read/write; D32 */
```

refers to the sis3820.h header file.

7.1 Control/Status Register(0x, write/read)

```
#define SIS3820_CONTROL_STATUS          0x0   /* read/write; D32 */
```

The control register is in charge of the control of some basic properties of the SIS3820 board, like enabling test pulse generators. It is implemented via a selective J/K register, a specific function is enabled by writing a 1 into the set/enable bit, the function is disabled by writing a 1 into the clear/disable bit (which location is 16-bit higher in the register). An undefined toggle status will result from setting both the enable and disable bits for a specific function at the same time.
On read access the same register represents the status register.

Bit	write Function	read Function
31		Status external LATCH Bit2 (depending on Input Mode)
30		Status external LATCH Bit1 (depending on Input Mode)
29		Status external Input Bit2 (depending on Input Mode)
28		Status external Input Bit1 (depending on Input Mode)
27		Overflow
26		0
25		Status HISCAL operation enable
24		Status Operation armed
23		Status Operation SDRAM/FIFO Test enabled
22	switch off reference pulser channel 1 (*)	0
21	counter test mode (*)	0
20	clear 25MHz test pulses (*)	0
19		0
18		Status Operation MCS enable (active)
17		0
16	switch off user LED (*)	Status Operation Scaler enable (active)
15		0
14		0
13		0
12		0
11		0
10		0
9		0
8		0
7		0
6	switch on 50 MHz reference pulser channel 1	Status reference pulser
5	enable counter test mode	Status counter test mode enable
4	enable 25MHz test pulses	Status 25MHz test pulses
3		0
2		0
1		0
0	switch on user LED	Status User LED (1=LED on, 0=LED off)

(*) denotes power up default setting, i.e. the power up reading of the register is 0x0

7.1.1 Counter test mode

VME Key test pulse signals will be counted by all (non inhibited) counters in test mode. Counter test mode has to be activated for 25 MHz test pulse operation also.

7.1.2 25 MHz test pulse mode

All (non inhibited) scaler channels will count 25 MHz test pulses if this bit and the counter test mode bit is set. From firmware 01 0A on you can use the test pulse mask register to exclude selected channels from participating in test pulse counting.

7.1.3 Reference pulser channel 1

Channel 1 will count 50 MHz reference pulses (precision defined by the on board 100 ppm 50 MHz quarz) if this bit is set.
Note: test mode has priority over reference pulser, i.e. reference pulses will not be counted if test mode (with or without 25 MHz test pulse mode) is active.

7.2 Module Id. and Firmware Revision Register (0x4, read)

```
#define SIS3820_MODID                    0x4   /* read only; D32 */
```

This register reflects the module identification of the SIS3820 and its minor and major firmware revision levels. The major revision level will be used to distinguish between substantial design differences and experiment specific designs, while the minor revision level will be used to mark user specific adaptations.

Bit	Function	Reading
31	Module Id. Bit 15	3
30	Module Id. Bit 14	
29	Module Id. Bit 13	
28	Module Id. Bit 12	
27	Module Id. Bit 11	8
26	Module Id. Bit 10	
25	Module Id. Bit 9	
24	Module Id. Bit 8	
23	Module Id. Bit 7	2
22	Module Id. Bit 6	
21	Module Id. Bit 5	
20	Module Id. Bit 4	
19	Module Id. Bit 3	0
18	Module Id. Bit 2	
17	Module Id. Bit 1	
16	Module Id. Bit 0	
15	Major Revision Bit 7	
14	Major Revision Bit 6	
13	Major Revision Bit 5	
12	Major Revision Bit 4	
11	Major Revision Bit 3	
10	Major Revision Bit 2	
9	Major Revision Bit 1	
8	Major Revision Bit 0	
7	Minor Revision Bit 7	
6	Minor Revision Bit 6	
5	Minor Revision Bit 5	
4	Minor Revision Bit 4	
3	Minor Revision Bit 3	
2	Minor Revision Bit 2	
1	Minor Revision Bit 1	
0	Minor Revision Bit 0	

7.2.1 Major revision numbers

Find below a table with major revision numbers used/reserved to date

Major revision number	Application/user
0x01	Generic SIS3820 32 channel scaler design
0xE0	SIS3820-CLOCK
0xF0	SIS3820-LATCH

7.3 Interrupt configuration register (0x8)

```
#define SIS3820_IRQ_CONFIG                0x8   /* read/write; D32 */
```

In conjunction with the interrupt control register this read/write register controls the VME interrupt behaviour of the SIS3820. Eight interrupt sources are foreseen, for the time being four of them are associated with an interrupt condition, the others are reserved for future use. The interrupter type is DO8 .

7.3.1 IRQ mode

In RORA (release on register access) mode the interrupt will be pending until the IRQ source is cleared by specific access to the corresponding disable VME IRQ source bit. After the interrupt is serviced the source has to be activated with the enable VME IRQ source bit again.
In ROAK (release on acknowledge) mode , the interrupt condition will be cleared (and the IRQ source disabled) as soon as the interrupt is acknowledged by the CPU. After the interrupt is serviced the source has to be activated with the enable VME IRQ source bit again. ROAK IRQ mode can be used in conjunction with the University of Bonn LINUX Tundra Universe II driver by Dr. Jürgen Hannappel on Intel based VME SBCs.

Bit	Function	Default
31		0
...		0
16		0
15		0
14		0
13		0
12	RORA/ROAK Mode (0: RORA; 1: ROAK)	0
11	VME IRQ Enable (0=IRQ disabled, 1=IRQ enabled)	0
10	VME IRQ Level Bit 2	0
9	VME IRQ Level Bit 1	0
8	VME IRQ Level Bit 0	0
7	IRQ Vector Bit 7; placed on D7 during VME IRQ ACK cycle	0
6	IRQ Vector Bit 6; placed on D6 during VME IRQ ACK cycle	0
5	IRQ Vector Bit 5; placed on D5 during VME IRQ ACK cycle	0
4	IRQ Vector Bit 4; placed on D4 during VME IRQ ACK cycle	0
3	IRQ Vector Bit 3; placed on D3 during VME IRQ ACK cycle	0
2	IRQ Vector Bit 2; placed on D2 during VME IRQ ACK cycle	0
1	IRQ Vector Bit 1; placed on D1 during VME IRQ ACK cycle	0
0	IRQ Vector Bit 0; placed on D0 during VME IRQ ACK cycle	0

The power up default value reads 0x 00000000

7.4 Interrupt Control/Status register (0xC)

```
#define SIS3820_IRQ_CONTROL                0xC   /* read/write; D32 */
```

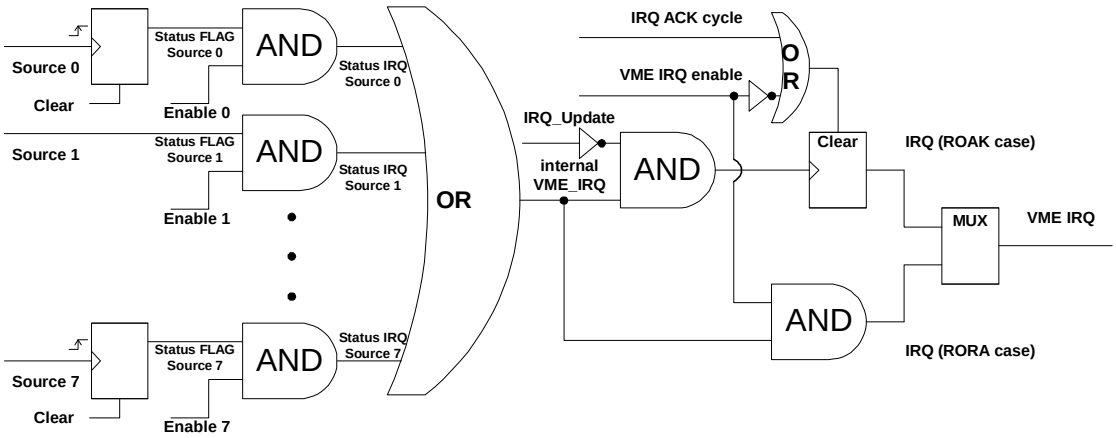
The interrupt sources are enabled with the interrupt control register. The interrupt source is cleared in the interrupt service routine. The status internal IRQ flag can be used for tests without activating VME interrupt generation. It is set whenever an interrupt would be generated if interrupting would be enabled in the interrupt configuration register.
fourth condition is reserved for future use.

Bit	Function (w)	(r)	Default
31	1 Shot : IRQ_UPDATE	Status IRQ source 7 (reserved)	0
30	unused	Status IRQ source 6 (reserved)	0
29	unused	Status IRQ source 5 (reserved)	0
28	unused	Status IRQ source 4 (FIFO almost full)	0
27	unused	Status IRQ source 3 (overflow)	0
26	unused	Status IRQ source 2 (acquisition completed)	0
25	unused	Status IRQ source 1 (FIFO threshold)	0
24	unused	Status IRQ source 0 (LNE/clock shadow)	0
23	Clear IRQ source 7	Status flag source 7	0
22	Clear IRQ source 6	Status flag source 6	0
21	Clear IRQ source 5	Status flag source 5	0
20	Clear IRQ source 4	Status flag source 4	0
19	Clear IRQ source 3	Status flag source 3	0
18	Clear IRQ source 2	Status flag source 2	0
17	Clear IRQ source 1	Status flag source 1	0
16	Clear IRQ source 0	Status flag source 0	0
15	Disable IRQ source 7	Status VME IRQ	0
14	Disable IRQ source 6	Status internal IRQ	0
13	Disable IRQ source 5	0	0
12	Disable IRQ source 4	0	0
11	Disable IRQ source 3	0	0
10	Disable IRQ source 2	0	0
9	Disable IRQ source 1	0	0
8	Disable IRQ source 0	0	0
7	Enable IRQ source 7	Status enable source 7 (read as 1 if enabled, 0 if disabled)	0
6	Enable IRQ source 6	Status enable source 6 (read as 1 if enabled, 0 if disabled)	
5	Enable IRQ source 5	Status enable source 5 (read as 1 if enabled, 0 if disabled)	0
4	Enable IRQ source 4	Status enable source 4 (read as 1 if enabled, 0 if disabled)	0
3	Enable IRQ source 3	Status enable source 3 (read as 1 if enabled, 0 if disabled)	0
2	Enable IRQ source 2	Status enable source 2 (read as 1 if enabled, 0 if disabled)	0
1	Enable IRQ source 1	Status enable source 1 (read as 1 if enabled, 0 if disabled)	0
0	Enable IRQ source 0	Status enable source 0 (read as 1 if enabled, 0 if disabled)	0

The power up default value reads 0x 00000000

Note: The clear IRQ source bits are relevant for edge sensitive IRQs only

The generation of the status flags, the IRQ flags and the actual IRQ is illustrated with the schematic below:



Note: Source 0 is shown as edge sensitive and source 1 as level sensitive input in the drawing above. Which interrupt sources are edge and level sensitive may vary from firmware implementation to firmware implementation.

7.4.1 Interrupt sources

A short explanation of the implemented interrupt sources is given in the following subsections.

7.4.1.1 LNE/clock shadow (IRQ source 0; edge sensitive)

In multiscaler or multi channel scaler (MCS) mode interrupt source 0 is associated to the LNE (load next event) signal. The interrupt is issued whenever a LNE signal triggers scaler value transfer to memory. The interrupt will be induced by the rundown of the preset value if LNE prescaling is active.
In scaler mode the LNE interrupt is driven by the clock shadow signal .

7.4.1.2 FIFO threshold (IRQ source 1; level sensitive)

The FIFO threshold IRQ source can be used for efficient readout in FIFO emulation mode. The interrupt will be triggered as soon as the number of data words in memory will reach the (non 0) value of the FIFO threshold register

7.4.1.3 Acquisition completed/Preset reached (IRQ source 2; edge sensitive)

The number of counting periods to acquire data can be defined with the acquisition preset register in MCS mode. The acquisition completed interrupt source can be used to trigger an interrupt with this condition. The interrupt is issued as soon as the preset is reached in preset scaler mode

7.4.1.4 Overflow (IRQ source 3; level sensitive)

The overflow interrupt source is triggered if one or more counters exceed the 32-bit range. The overflow registers can be used to identify the channel that has caused the interrupt. Overflow interrupt generation is active in non clearing mode only.

7.4.1.5 FIFO almost full (IRQ source 4; edge sensitive)

This interrupt source can be used to catch the FIFO almost full error condition. It is set if the fill level of the SDRAM exceeds 64 MB-512 words in FIFO mode. The condition has to be resolved by a KEY_SDRAM_FIFO_RESET.

7.5 (0x10)Acquisition preset register

```
#define SIS3820_ACQUISITION_PRESET       0x10  /* read/write; D32 */
```

This read/write register allows you to define the number of counting periods to acquire in MCS mode. The preset value is 32-bit wide. A preset value of 0 results in continuous MCS operation.
Further LNEs are ignored after completion of acquisition until a key reset acquisition VME access is performed. The completion flag is cleared upon reset acquisition also.

Bit	Function
31	bit 31 of preset value
...	...
0	bit 0 of preset value

- The register can be used in scaler mode also
- it is not associated with a direct interrupt. Interrupt generation can be accomplished in conjunction with the “acquisition completed (IRQ source 2, edge sensitive)
- The status flag of the active mode (scaler enabled e.g.) will be cleared upon completion

7.6 Acquisition count register (0x14)

```
#define SIS3820_ACQUISITION_COUNT        0x14  /* read  D32 */
```

This 32-bit wide read only register holds the number of acquisitions. It is cleared with the start operation and incremented with consecutive LNE pulses. The contents of the acquisition count register is compared with the contents of the acquisition preset register if the later is non zero. Acquisition is completed as soon as the acquisition count is greater or equal than the acquisition preset value.

Bit	Function
31	bit 31 of acquisition count
...	...
0	bit 0 of acquisition count

7.7 LNE Prescaler factor register (0x18)

```
#define SIS3820_LNE_PRESCALE              0x18  /* read/write; D32 */
```

The LNE prescale factor register allows you to prescale the front panel LNE pulse (clock ticks from an angular encoder e.g.), the internal 10 MHz pulse generator or the channel N (ChN) LNE source. The prescale factor is a 32-bit value. The second case above allows you to run the multiscaler with a fixed time slice length. The register can be reprogrammed while the scaler acquires data as long as the user makes sure not to change the prescale factor while an internal reload is in progress. The period between two CIP pulses is safe for reprogramming. Programming the prescale factor to 0 results in routing the raw signal to the LNE. If the LNE rate after the prescaler is higher than the possible maximum, excess LNE pulses are ignored, the CIP output allows you to monitor the accepted LNE pulses.

Bit	Function
31	LNE prescale factor bit 31
...	...
0	LNE prescale factor bit 0

If the new prescale factor is supposed to have an immediate effect (i.e. if the new prescale factor and the input rate are smaller than the previous setting), following sequence has to be used:

1.) disable LNE prescaler (write 0x0 to the LNE prescaler factor register)
2.) enable LNE prescaler (by writing the new LNE prescale value to the LNE prescaler factor register)

The LNE prescale factor is given by **register value+1.**
If the an output mode with CIP front panel output is enabled, the CIP signal can be used to synchronise external hardware to the actual LNE pulses after prescaling.

Example: If 9999 (decimal) is written to the LNE prescale factor register with the prescaler and the 10 MHz to prescaler enabled (via bits 6 and 7 of the control register), the scaler will get LNE pulses with a frequency of 1 KHz.

Following LNE sources are routed through the LNE prescaler if the prescale factor has a non zero value:

external LNE (front panel signal)
internal 10 MHz
channel N (ChN)

Note 1: This implies, that software LNE pulses are not routed through the LNE prescaler, they do always initiate a direct LNE/readout cycle

Note 2: The external LNE and channel N rate is limited to 5 MHz

7.8 Preset value register counter group 1 (0x20)

```
#define SIS3820_PRESET_GROUP1       0x20        /* read/write; D32 */
```

The preset value for channels 1-16 is defined by this register. The preset channel select register is used to define which of the 16 channels of the group is actually compared to the preset value.

Bit	Function
31	Preset bit 31
...	...
0	Preset bit 0

7.9 Preset value register counter group 2 (0x24)

```
#define SIS3820_PRESET_GROUP2       0x24        /* read/write; D32 */
```

The preset value for channels 17-32 is defined by this register. The preset channel select register is used to define which of the 16 channels of the group is actually compared to the preset value.

Bit	Function
31	Preset bit 31
...	...
0	Preset bit 0

7.10 Preset Enable and Hit register (0x28)

```
#define SIS3820_PRESET_ENABLE_HIT   0x28        /* read/write; D32 */
```

This register is used to enable one or both counter groups for preset operation and provides the information which group has reached the preset value.

Bit	write Function	read Function
18	none	LNE latched preset reached status group 2 0: channel group 2 has not reached preset value 1: channel group 2 has reached preset value
17	none	preset reached status group 2 0: channel group 2 has not reached preset value 1: channel group 2 has reached preset value
16	ENABLE group 2	Status ENABLE group 2
		...
2	none	LNE latched preset reached status group 1 0: channel group 1 has not reached preset value 1: channel group 1 has reached preset value
1	none	preset reached status group 1 0: channel group 1 has not reached preset value 1: channel group 1 has reached preset value
0	ENABLE group 1	Status ENABLE group 1

At power up or after key reset the register the register will read 0.

7.11 CBLT/Broadcast setup register

```
#define SIS3820_CBLT_BROADCAST_SETUP      0x30  /* read/write; D32 */
```

This read/write register defines, whether the SIS3820 will participate in a CBLT and/or Broadcast. The configuration of this register and the registers of other participating modules is essential for proper CBLT and/or Broadcast behaviour.
CBLT is supported from the SDRAM in FIFO emulation mode (MCS Mode).

Bit	Function
31	CBLT/Broadcast address bit 31
30	CBLT/Broadcast address bit 30
29	CBLT/Broadcast address bit 29
28	CBLT/Broadcast address bit 28
27	CBLT/Broadcast address bit 27
26	CBLT/Broadcast address bit 26
25	CBLT/Broadcast address bit 25
24	CBLT/Broadcast address bit 24
23	CBLT MAX Readout Length Bit 7
22	CBLT MAX Readout Length Bit 6
21	CBLT MAX Readout Length Bit 5
20	CBLT MAX Readout Length Bit 4
19	CBLT MAX Readout Length Bit 3
18	CBLT MAX Readout Length Bit 2
17	CBLT MAX Readout Length Bit 1
16	CBLT MAX Readout Length Bit 0
15	CBLT Geographical address bit 4 (use for Header and Trailer)
14	CBLT Geographical address bit 3
13	CBLT Geographical address bit 2
12	CBLT Geographical address bit 1
11	CBLT Geographical address bit 0
10	0
9	0
8	0
7	0
6	0
5	Enable Broadcast Master
4	Enable Broadcast
3	0
2	First (to be set to 1 on the first module in the CBLT chain)
1	Last (to be set to 1 on the last module in the CBLT chain)
0	enable CBLT (to be set to 1 on all modules in the CBLT chain)

The function/meaning of the CBLT and the geographical address is illustrated in section. 15.9.1.

7.12 SDRAM page register (0x34)

```
#define SIS3820_SDRAM_PAGE                0x34    /* read/write; D32 */
```

This read/write register was implemented to reduce the address space that is occupied by the SIS3820. The idea is to divide the SDRAM -that can have a size of up to 1024 Mbytes- into 8 MByte pages. The contents of the SDRAM page register defines what 8 MByte page is addressed. The page will be incremented automatically during a block transfer (BLT32, MBLT64, 2eVME)beyond a page boundary. This will allow you to read large chunks of memory with the SIS3100 VME sequencer and similar hardware in one go.
The page number is not modified by the MCS scaler data acquisition process.

Bit	Function	
31	none, read as 0	
...	...	
9	none, read as 0	
8	memory size bit: 0: 64 MB, 1: 512 MB	
7	none, read as 0	
6	none, read as 0	
5	page number bit 5	used with 512 MByte strip
4	page number bit 4	
3	page number bit 3	
2	page number bit 2	used with 64 MByte strip
1	page number bit 1	
0	page number bit 0	

The power up value for the page number is 0.

7.13 FIFO word counter/memory address pointer register (0x38)

```
#define SIS3820_FIFO_WORDCOUNTER         0x38  /* read; D32 */
```

This read only register holds SDRAM fill level information.

Bit	Function
31	none, read as 0
...	...
28	none, read as 0
27	none, read as 0
26	word counter bit 26
...	...
1	word counter bit 1
0	word counter bit 0

The word counter is

- cleared upon SIS3820_KEY_RESET and SIS3820_KEY_SDRAM_FIFO_RESET
- incremented on data being written to SDRAM/FIFO (in MCS mode or SDRAM/FIFO VME write test mode)
- decremented when data are read from the memory by VME

Note: if you read the same data from SDRAM more than once (in non FIFO mode), the word counter will not reflect the actual fill level (i.e. FIFO mode is the main word counter application).

SDRAM Address pointers (non VME accessible)
In FIFO Mode:

- the write pointer is reset upon SIS3820_KEY_RESET and SIS3820_KEY_SDRAM_FIFO_RESET
- the write pointer is incremented upon SDRAM write cycles (MCS mode ..)
- the read pointer is decremented upon SDRAM VME read cycles

In SDRAM Mode:

- write and read pointers are reset upon SIS3820_KEY_RESET and SIS3820_KEY_SDRAM_FIFO_RESET
- the write pointer is incremented upon SDRAM write cycles (MCS mode ..)
- the read pointer is defined by the VME address

An internal FIFO almost full flag, which blocks further writes/LNEs, is generated in FIFO mode at 64 MBytes – 512 words (512 MBytes- 512 words respective). Data from up to two LNE cycles may be pipelined and still be written to memory at this point. . This condition reflects the error case and has to be avoided by readout in parallel to acquisition. It is available as interrupt source 4 and has to be cleared with a SIS3820_KEY_SDRAM_FIFO_RESET.

7.14 FIFO word counter threshold (0x3C)

```
#define SIS3820_FIFO_WORDCOUNT_THRESHOLD 0x3C  /* read/write; D32 */
```

This read/write only register holds the fill level threshold for interrupt generation. The FIFO word counter (longword, i.e. number of 32-bit words) threshold is compared to the FIFO word counter register contents, an interrupt is generated as soon as the number of data words in the SDRAM exceeds the threshold.

Bit	Function
31	none, read as 0
...	...
28	none, read as 0
27	none, read as 0
26	FIFO word counter threshold bit 26
...	...
1	FIFO word counter threshold bit 1
0	FIFO word counter threshold bit 0

Notes:

- in principle memory strips of up to 512 MByte can be handled with this 27-bit deep FIFO word counter threshold implementation
- the 3820 01 02 firmware will flag a FIFO error as soon as 64 MB – 512 longwords (512 MB –512 respective) are reached (with the possibility of data words still being buffered in pipelines and being stored without data loss).

7.15 HISCAL_START_PRESET register (0x40)

```
#define SIS3820_HISCAL_START_PRESET      0x40      /* read/write; D32 */
```

The number of scans in HISCAL operation can be preset/limited with this 32-bit deep register. The An entry of 0 (power up default) results in scanning operation until a KEY reset or KEY HISCAL_OPERATION_DISABLE command is issued.

7.16 HISCAL_START_COUNTER register (0x44)

```
#define SIS3820_HISCAL_START_COUNTER      0x44      /* read only; D32 */
```

This 32-bit deep register holds the number of scans/starts in HISCAL operation. The register content is updated with the start signal/pulse.

7.17 HISCAL_LAST_ACQ_COUNTER register (0x48)

```
#define SIS3820_LAST_ACQ_COUNTER      0x48      /* read only; D32 */
```

This 32-bit deep register holds the number of bins of the last scan (i.e. the contents of the acquisition count register at the end of the scan). It is updated with the start in HISCAL operation.

7.18 (Acquisition) Operation Mode register (0x100)

```
#define SIS3820_ACQUISITION_MODE      0x100      /* read/write; D32 */
```

Bit	Function	Default
31	reserved	0
30	Operation Mode bit 2	0
29	Operation Mode bit 1	0
28	Operation Mode bit 0	0
27	Reserved	0
26	Reserved	0
25	Reserved	0
24	reserved	0
23	Control outputs inverted	0
22	reserved	0
21	Control output mode bit 1	0
20	Control output mode bit 0	0
19	Control inputs inverted	0
18	Control input mode bit 2	0
17	Control input mode bit 1	0
16	Control input mode bit 0	0
15	reserved	0
14	HISCAL_START_SOURCE_BIT	0
13	select SDRAM add mode	0
12	select SDRAM mode	0
11	Reserved	0
10	Reserved	0
9	Arm/Enable source bit 1	0
8	Arm/Enable source bit 0	0
7	Reserved	0
6	LNE source bit 2	0
5	LNE source bit 1	0
4	LNE source bit 0	0
3	data format bit 1	0
2	data format bit 0	0
1	Reserved	0
0	select non clearing mode	0

The power up default value reads 0x 00000000

7.18.1 Modes of Operation modes (Bits 30:28)

Op Mode bit 2	Op Mode bit 1	Op Mode bit 0	Mode of operation
0	0	0	Scaler/Counter, Latching Scaler, Preset Scaler
0	0	1	reserved
0	1	0	Multi channel Scaler
0	1	1	reserved
1	0	0	reserved
1	0	1	reserved
1	1	0	reserved
1	1	1	SDRAM/FIFO VME write test mode

7.18.2 Input modes (Bits 18:16)

The SIS3820-SCALER board has 4 control inputs. They can be assigned to different signals with the 3 input modes bit of the acquisition/operation mode register as listed in the table below. All inputs can be inverted with the control inputs inverted bit of the same register.

Control Input Mode	Input assignment
Mode 0 (bit2=0, bit1=0, bit0=0)	input 1 -> no function input 2 -> no function input 3 -> no function input 4 -> no function
Mode 1 (bit2=0, bit1=0, bit0=1)	input 1 -> external next pulse (LNE)/clock shadow input 2 -> external user bit 1 input 3 -> external user bit 2 input 4 -> inhibit LNE
Mode 2 (bit2=0, bit1=1, bit0=0)	input 1 -> external next pulse (LNE) /clock shadow input 2 -> external user bit 1 input 3 -> inhibit counting input 4 -> inhibit LNE
Mode 3 (bit2=0, bit1=1, bit0=1)	input 1 -> external next pulse (LNE) /clock shadow input 2 -> external user bit 1 input 3 -> external user bit 2 input 4 -> inhibit counting
Mode 4 (bit2=1, bit1=0, bit0=0)	input 1 -> inhibit counting channels 1-8 input 2 -> inhibit counting channels 9-16 input 3 -> inhibit counting channels 17-24 input 4 -> inhibit counting channels 25-32
Mode 5 (bit2=1, bit1=0, bit0=1)	input 1 -> external next pulse (LNE) input 2 -> external HISCAL_START (time reset/start pulse) input 3 -> no function input 4 -> no function
Mode 6 (bit2=1, bit1=1, bit0=0)	input 1 -> external next pulse (LNE) /clock shadow input 2 -> inhibit counting input 3 -> clear all counters input 4 -> external user bit 1
Modes 7 (reserved)	input 1 -> Encoder Input A input 2 -> Encoder Input B input 3 -> Encoder Input I input 4 -> inhibit counting

Note: following LNE sources are affected by the LNE inhibit input

external LNE (front panel signal)
internal 10 MHz
channel N (ChN)

7.18.3 Output mode (Bits 21:20)

The SIS3820-SCALER board has 4 control outputs. They can be assigned to different signals with the 2 output modes bit of the acquisition/operation mode register as listed in the table below. All outputs (except the selected MUX OUT channel in mode 3) can be inverted with the control outputs inverted bit of the same register.

Control Output Mode	Output assignment
Mode 0 (bit1=0, bit0=0)	output 5 -> Scaler mode : LNE pulse ; MCS Mode: CIP output 6 -> SDRAM empty output 7 -> SDRAM threshold output 8 -> User output (Led)
Mode 1 (bit1=0, bit0=1)	output 5 -> Scaler mode : LNE pulse ; MCS Mode: CIP output 6 -> Enabled output 7 -> 50 MHz output 8 -> User output (User LED)
Mode 2 (bit1=1, bit0=0)	output 5 -> Scaler mode : LNE pulse ; MCS Mode: CIP output 6 -> 10 MHz (20ns pulse) output 7 -> 10 MHz (20ns pulse) output 8 -> User output (User LED)
Modes 3 (01 0A onward) (bit1=1, bit0=1)	output 5 -> Scaler mode : LNE pulse ; MCS Mode: CIP output 6 -> 10 MHz (20ns pulse) output 7 -> selected MUX OUT channel output 8 -> User output (User LED)

Note: The user output is switched on and off with the same bit of the control register as the user LED.

7.18.4 HISCAL_START_SOURCE_BIT (Bit 14)

The HISCAL_START_SOURCE_BIT defines whether the HISCAL_START is derived from a VME KEY Start or from the HISCAL_START front panel input (input 2 with input mode=5)

HISCAL_START_SOURCE_BIT	HISCAL_START_SOURCE
0	VME_KEY_START
1	external HISCAL_START (in conjunction with input mode 5)

7.18.5 SDRAM mode (Bit 12) and SDRAM add mode (Bit 13)

The SDRAM mode bit defines whether the the SIS3820 is operated in SDRAM or FIFO emulation mode
In SDRAM add mode the SIS3820 operates in SDRAM mode always (independent of the SDRAM mode bit setting). An SDRAM add bit setting of one in combination with MCS mode of operation results in HISCAL (hsitogramming scaler) operation.

SDRAM add mode bit	SDRAM mode bit	Mode
0	0	FIFO emulation
0	1	SDRAM
1	0	SDRAM
1	1	SDRAM

7.18.6 Arm/enable source

The two arm/enable source bits define what signal the enable is derived from. In channel N source mode the LNE channel register defines what scaler channel the enable signal is derived from.

Arm/Enable Bit 1	Arm/Enable Bit 0	Arm/Enable source
0	0	LNE Front panel control signal
0	1	Channel N (ChN)
1	0	reserved
1	1	reserved

Notes:
1.) be aware, that the front panel control signal is active with input modes 1, 2, 3, 5 and 6 only
2.) ChN stands for the selected LNE channel

7.18.7 LNE source

The three LNE source bits define what signal the LNE (load next event) signal is derived from. In channel N source mode the LNE channel register defines what scaler channel the LNE signal is derived from.

LNE Bit 2	LNE Bit 1	LNE Bit 0	LNE source
0	0	0	VME key address only (ignore front panel signals)
0	0	1	Front panel control signal
0	1	0	10 MHz internal pulser
0	1	1	Channel N (ChN)
1	0	0	Preset Scaler N (MCS only)
1	0	1	Encoder pulse

LNE sources can be prescaled with the LNE prescaler where needed. The LNE prescaler is active if the prescale factor register is loaded with a non zero value.

Routed through LNE prescaler if ≠ 0	LNE source
no	VME key address only (ignore front panel signals)
yes	Front panel control signal
yes	10 MHz internal pulser
yes	Channel N (ChN)
no	Preset Scaler N
yes	Encoder pulse

Note 1: The maximum input frequency for the channel N or front panel LNE is limited to 10 MHz

Note 2: The external LNE and channel N rate is limited to 5 MHz

7.18.8 Data format

The data format bits allow you to select between a straight 32-bit and a 24-bit mode with information from the two user inputs and channel information. For low rate and/or short dwell time environments data reduction and lower dwell times can be accomplished by reduction of the scaler depth to 16-bit or even 8-bit. Two respective four scaler values are packed into one 32-bit word in that case.

Format Bit 1	Format Bit 0	Data Format
0	0	32-bit
0	1	24-bit with user bit and channel information
1	0	16-bit (MCS only)
1	1	8-bit (MCS only)

A more detailed description of the data formats is given in section 8.

7.18.9 Clearing/non clearing

This bit decides, whether the scaler values are cleared upon LNE/clock shadow, or whether the counter contents will be preserved and the accumulated counts will be stored to SDRAM/to the shadow registers. The power up mode defaults to clearing, i.e. the number of counts since the last readout cycle will be stored to SDRAM/to the shadow registers.

Refer to section 15.6 for a description of the function/behavior internal counter logic

Note: The overflow logic (generation of overflow IRQ e.g.) is active in non clearing mode only.

7.19 Copy disable register (0x104)

```
#define SIS3820_COPY_DISABLE          0x104      /* read/write; D32 */
```

This read/write register allows for exclusion of channels from the LNE (MCS mode)

The full copy loop is executed in pattern mode. Channels with their corresponding bit set in the copy disable register are excluded from the copy process.
The minimum dwell time depend on the number of active channels and the selected data format (refer to section 15.2 for a table of measured minimum dwell times).

Bit	Function
31	copy disable bit channel 32
...	...
0	copy disable bit channel 1

Examples: If 0xFFFF is written to the copy disable register, channels 17 through 32 data will be copied to memory, if 0xFFFF0000 is set channels 1 through 16 will be stored.

Note on copy disable behavior/limitations:

Data forma	Copy disable behavior/limitations
32 or 24-bit	Arbitrary channels can be disabled in a selective fashion
16-bit	Groups of 2 channel pairs are copied Ch1 and 2, Ch2 and 4 e.g. The corresponding dual channel group is copied if the disable bit of the first channel of the group (Ch1, 3, e.g.) is not set
8-bit	Groups of 4 channel are copied Ch1, 2, 3 and 4, Ch5, 6, 7 and 8 e.g. The corresponding four channel group is copied if the disable bit of the first channel of the group (Ch1, 5, e.g.) is not set

7.20 LNE channel select register (0x108)

```
#define SIS3820_LNE_CHANNEL_SELECT          0x108      /* read/write; D32 */
```

This read/write register allows to define which of the 32 front panel scaler channels is used as LNE source in LNE channel N mode. The LNE channel has to be selected before the counting process is started and can not be changed during acquisition.

Bit	Function
31	no function, read as 0
...	...
5	no function, read as 0
4	bit 4 of LNE channel
3	
2	
1	...
0	bit 0 of LNE channel

Notes:
1.) The maximum input frequency for the LNE channel is limited to 10 MHz
2.) An inhibit of the selected channel (front panel or selective count disable) is ignored

Hint: make sure to activate the channel N LNE source in the acquisition/operation mode register

7.21 PRESET channel select register (0x10C)

```
#define SIS3820_PRESET_CHANNEL_SELECT      0x10C      /* read/write; D32 */
```

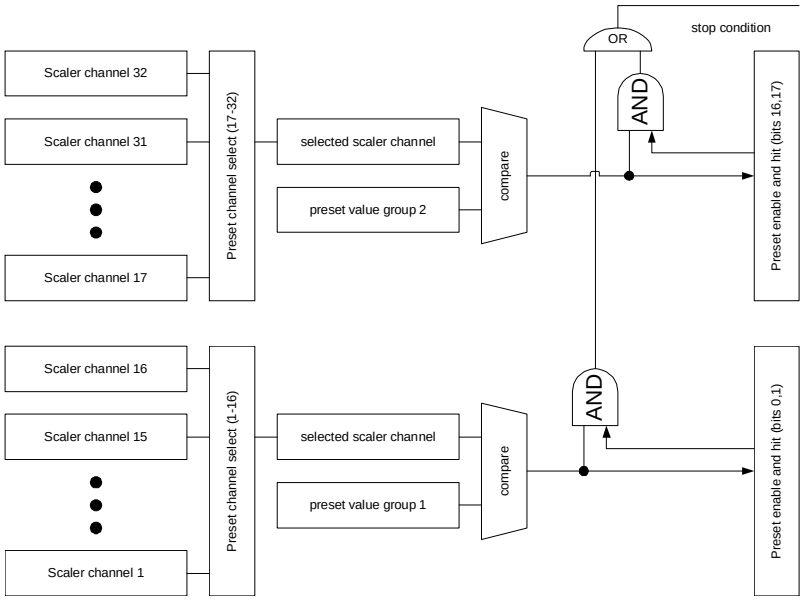
This read/write register allows to define which of the 32 front panel scaler channels is used as LNE source in LNE channel N mode. The LNE channel has to be selected before the counting process is started and can not be changed during acquisition. The channels are divided into two groups of 16 channels each due to the architecture of the SIS3820.

Bit	Function
31	no function, read as 0
...	...
20	no function, read as 0
19	bit 3 of PRESET channel select group2
18	...
17	...
16	bit 0 of PRESET channel select group2
15	no function, read as 0
...	...
4	no function, read as 0
3	bit 3 of PRESET channel select group1
2	...
1	...
0	bit 0 of PRESET channel select group1

Example: a setting of 0x00000004 selects channel 5 as preset/ChN LNE source

7.21.1 Preset scheme

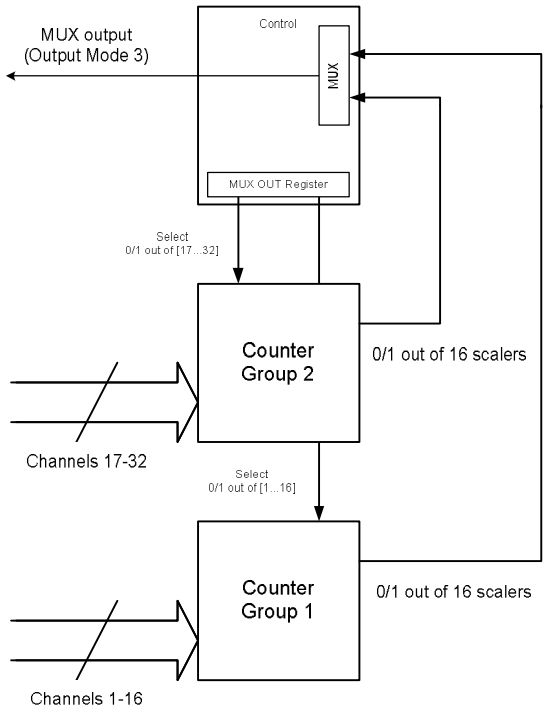
The overall preset scheme of the SIS3820 scaler is illustrated below.



7.22 MUX OUT channel select register (0x110)

```
#define SIS3820_MUX_OUT_CHANNEL_SELECT      0x110     /* read/write; D32 */
```

MUX functionality (available from firmware 01 0A on) allows to route one of the 32 scaler input signals to an external instrument like a visual rate meter e.g.



Register Bit assignments:

Bit	Function
31	no function, read as 0
...	...
5	no function, read as 0
4	bit 4 of OUT_MUX channel
3	
2	
1	...
0	bit 0 of OUT_MUX channel

Notes:
1.) The power up default is0x0 (i.e. scaler channel 0 is routed to the output as soon as output mode 3 is activated)
2.) MUX_OUT mode requires output mode 3

Example:
Channel 5 (channels counted from 0 to 31) is passed to output 7 with bit 0 and 2 of the MUX OUT channel select register set and output mode 3 enabled

7.23 Inhibit/count disable register (0x200)

```
#define SIS3820_INHIBIT          0x200      /* read/write; D32 */
```

This read/write register is used for software inhibit of individual channels or arbitrary channel groups. The inhibit condition is an OR of the front panel inhibit (where activated) and the inhibit register.

Bit	Function
31	0: enable /1: inhibit channel 32 counting
...	...
0	0: enable /1: inhibit channel 1 counting

At power up or after key reset the register the register will read 0, i.e. all scaler channels are active.

7.24 Counter clear register (0x204)

```
#define SIS3820_COUNTER_CLEAR            0x204       /* write only; D32 */
```

On write access to this register each channel can be cleared individually by the setting of the corresponding bit.

Bit	write Function
31	1: clear channel 32
...	...
0	1: clear channel 1

7.25 Counter Overflow register (0x208)

```
#define SIS3820_COUNTER_OVERFLOW         0x208       /* read/write; D32 */
```

This register holds the information on which channel has run into overflow condition.

On write access to this register the overflow bits of each channel can be cleared individually by the setting of the corresponding bit.

Bit	write Function	read Function
31	1: clear overflow bit of channel 32	Status of Overflow bit of channel 32
...	...	...
0	1: clear overflow bit of channel 1	Status of Overflow bit of channel 1

7.26 Channel 1/17 Bits 33-48 register (0x210)

```
#define SIS3820_COUNTER_48BIT_EXTENSION   0x210       /* read only D32 */
```

This register holds the upper 16 bits of channels 1 and 17 (from firmware version 01 04 onwards). It is used in scaler mode (and typically it will make sense in non clearing mode mainly)

Bit	read Function
31	Bit 48 of scaler channel 17
...	...
16	Bit 33 of scaler channel 17
15	Bit 48 of scaler channel 1
...	
0	Bit 33 of scaler channel 1

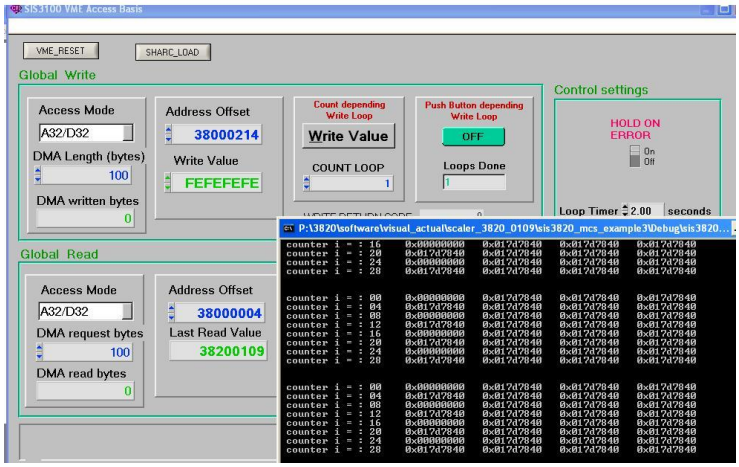
7.27 Veto external count inhibit register (0x214)

```
#define SIS3820_VETO_EXTERNAL_COUNT_INHIBIT     0x214       /* r/w D32 */
```

This register can be used to veto the external inhibit (input modes 1, 2, 3, 4 and 6) for individual scaler channels. By default the veto function is switched off for all channels.

Bit	Function
31	Veto external count inhibit channel 32 0: do not veto (power up default), 1: veto external inhibit
...	
0	Veto external count inhibit channel 1 0: do not veto (power up default), 1: veto external inhibit

Application example: measure up to 4 (input mode 4) gate open/closed ratios with internal (channel 1) or external (other channels) reference clocks. By writing 0xFEFEFEFE to the register and using input mode 4 you can use channel 1, 9, 17 and 25 gated with control input 1, 2, 3 and 4 respective as reference clocks (as shown in the screen dump below with all channels counting with the 25 MHz internal test pulser and all control inputs set).



7.28 Test pulse mask register (0x218)

```
#define SIS3820_TEST_PULSE_MASK                 0x218      /* r/w  D32 */
```

This register can be used to mask the 25 MHz test pulser from selected channels.

Bit	Function
31	Mask test pulser channel 32 0: do not mask (power up default), 1: mask test pulser
...	
0	Mask test pulser channel 1 0: do not mask (power up default), 1: mask test pulser

Application: This register is particularly useful in combination with the veto external count inhibit register. and with input mode 4 (4 count inhibit groups) . You can use the 25 MHz test pulser on channels 9, 17 and 25 and the 50 MHz reference pulser on channel 1 e.g. in combination with the proper veto external count inhibit pattern set to measure the inhibit set /no inhibit set fraction of the 4 control inputs.

7.29 SDRAM SPD register (0x300)

```
#define SIS3820_SDRAM_EEPROM_CTRL_STAT    0x300      /* read/write; D32 */
```

This register allows access to the serial PROM on the SDRAM memory strip of the SIS3820. Refer to the Visual C++ example sis3820_sdram_eeprom.c for an example on the use of the register.

Bit	write Function	read Function
31	none	0
...	...	...
12	none	0
11	none	0
10	none	0
9	none	SDA_IN
8	none	SDA_IN_LATCH
7	none	0
...		...
4	none	0
3		0
2	SDA_OUT_EN (1: enable SDA)	0
1	SDA_OUT (serial data out)	0
0	SCL (serial clock)	0

7.30 JTAG_TEST register (0x310)

```
#define SIS3820_JTAG_TEST    0x310                    /* write; D32;  */
```

This register is used in the firmware upgrade process over VME only. A TCK is generated upon a write cycle to the register.

Bit	write Function
31	none
...	...
4	none
3	none
2	none
1	TMS
0	TDI

7.31 JTAG_DATA_IN register(0x310)

```
#define SIS3820_JTAG_DATA_IN    0x310                  /* read; D32;  */
```

This register is used in the firmware upgrade process over VME only. It is at the same address as the JTAG_TEST register and is used in read access. It operates as a shift register for TDO. The contents of the register is shifted to the right by one bit with every positive edge of TCK and the status of TDO is transferred to Bit 30. Bit 31 reflects the current value of TDO during a read access.

7.32 JTAG_CONTROL register(0x314)

```
#define SIS3820_JTAG_CONTROL    0x314                  /* write only; D32;
*/
```

This register is used in the firmware upgrade process over VME only.

Bit	write Function
31	none
...	...
4	none
3	none
2	none
1	none
0	1: Enable JTAG output

7.33 Key address KEY_RESET (0x400)

```
#define SIS3820_KEY_RESET                    0x400
```

A write with arbitrary data to this address resets the module to the power up status.

7.34 Key address KEY_SDRAM_FIFO_RESET (0x404)

```
#define SIS3820_KEY_SDRAM_FIFO_RESET         0x404
```

A write with arbitrary data to this address resets the memory logic.

7.35 Key address KEY_TEST_PULSE (0x408)

```
#define SIS3820_KEY_TEST_PULS                0x408
```

A write with arbitrary data to this address increments the enabled counters by one count.

Prerequisites:

- Test mode enabled (write 0x20 to control register 0x0)
- Module enabled (write arbitrary data to key address 0x418)

7.36 Key address KEY_COUNTER_CLEAR (0x40C)

```
#define SIS3820_KEY_COUNTER_CLEAR            0x40C
```

A write with arbitrary data to this address clears all counters.

Note: Unless non clearing mode is activated (by a write with datum 1 to offset 0x100), the counters will be cleared upon readout also.

7.37 Key address KEY_LNE_PULSE (0x410)

```
#define SIS3820_KEY_LNE_PULS                 0x410
```

A write with arbitrary data to this address issues a LNE (load next event) or clocks the counter values to the shadow register set.

7.38 Key address KEY_OPERATION_ARM (0x414)

```
#define SIS3820_KEY_OPERATION_ARM                    0x414
```

A write with arbitrary data to this address arms the module in MCS mode.
Refer to the example code sis3820_mcs_ext.c also.

```
/* enable HISCAL operation with LNE_ARM (first LNE starts counting)*/
addr = mod_base + SIS3820_KEY_HISCAL_ENABLE_LNE_ARM ;
return_code = vme_A32D32_write(&gl_sis1100_device, addr, 0x0) ;
```

7.39 Key address KEY_OPERATION_ENABLE (0x418)

```
#define SIS3820_KEY_OPERATION_ENABLE                 0x418
```

A write with arbitrary data to this address enables operation/counting. The S (Scaler enable) LED will come on (unless are channels are disabled).

7.40 Key address KEY_OPERATION_DISABLE (0x41C)

```
#define SIS3820_KEY_OPERATION_DISABLE                0x41C
```

A write with arbitrary data to this address disables operation/counting. The S (Scaler enable) LED will go off.

7.41 Key address KEY_HISCAL_STARTPULS (0x420)

```
#define SIS3820_KEY_HISCAL_START_PULS                0x420
```

A write with arbitrary data to this address issues a start pulse in HISCAL mode.

7.42 Key address KEY_HISCAL_ENABLE_LNE_ARM (0x424)

```
#define SIS3820_KEY_HISCAL_ENABLE_LNE_ARM       0x424
```

A write with arbitrary data to this address enables LNE arm in HISCAL mode.

7.43 Key address KEY_HISCAL_ENABLE_LNE_ENABLE (0x428)

```
#define SIS3820_KEY_HISCAL_ENABLE_LNE_ENABLE    0x428
```

A write with arbitrary data to this address issues a start pulse in HISCAL mode.

```
      /* enable HISCAL operation   */
      addr = mod_base + SIS3820_KEY_HISCAL_ENABLE_LNE_ENABLE ;
      return_code = vme_A32D32_write(&gl_sis1100_device, addr, 0x0) ;
```

Refer to the example sis3820_histogram_example1.c also.

7.44 Key address KEY_HISCAL_DISABLE (0x42C)

```
#define SIS3820_KEY_HISCAL_DISABLE                   0x42C
```

A write with arbitrary data to this address disables HISCAL mode.

7.45 Counter Shadow Registers (0x800-0x87C)

```
#define SIS3820_COUNTER_SHADOW_CH1                0x800
```

This set of 32 registers holds the shadowed counter values. It is updated under two conditions:

- Key Clock Shadow
- Read access to the first counter register

D32 and BLT32 access is supported.

7.46 Counter Registers (0xA00-0xA7C)

```
#define SIS3820_COUNTER_CH1                       0xA00
```

This set of 32 registers holds the counter values.

Read access to the counter registers clocks the data to the shadow registers and returns the current counter values. D32 and BLT32 access is supported.

7.47 One wire Id. register (tbd)

(reserved for possible future implementation)

```
#define SIS3820_ONE_WIRE    0xtbd        /* read/write; D32;  */
```

A DS2430 256-Bit 1-wire EEPROM is installed on the SIS3820 to store the serial number of the module. This information is stored in the 64-bit
A DS2430 256-Bit 1-wire EEPROM is installed on the SIS3820 to store the serial number of the module. This information is stored in the 64-bit application register of the DS2430 in the factory.

Offset	Contents	Example SIS3820-64 SN 10
0	Module Id.	0x38
1		0x20
2	SDRAM size	0x00
3		0x64
4	Serial Number	0x00
5		0x00
6		0x00
7		0x0A

Note: Module Id. and SDRAM size are stored in hexadecimal form for better readability; the serial number is stored as straight 32-bit decimal value.

Refer to the PDF data sheet of the DS2430 and the LINUX example program rom_read.c on the SIS3820 documentation CDROM for details on the operation of the EEPROM.

Bit	Read function	Write function
31	0	not used
...	...	
16	0	not used
15	BUSY	cmd RESET
14	Present	cmd WRITE
13	0	cmd READ
12	0	reserved
11	0	reserved
10	0	reserved
9	reserved	reserved
8	reserved	reserved
7	read datum bit7	write datum bit7
6	read datum bit6	write datum bit6
5	read datum bit5	write datum bit5
4	read datum bit4	write datum bit4
3	read datum bit3	write datum bit3
2	read datum bit2	write datum bit2
1	read datum bit1	write datum bit1
0	read datum bit0	write datum bit0

7.48 FIFO address space (0x800000-0xFFFFFC)

```
#define SIS3820_FIFO_BASE           0x800000      /* read only; D32/BLTs */
```

Scaler data can be read from the FIFO address space in FIFO emulation mode. Both single cycle (D32) and block transfer modes (BLT32, MBLT64, 2eVME) are supported. The FIFO address space spans 8 MBytes (or 2 M long words) to allow for block transfer with auto address incrementing VME masters.
A VME bus error (BERR) is driven actively by the SIS3820 if you attempt to read from an empty FIFO.

7.48.1 non incrementing VME master

With a non auto incrementing VME master (like the SIS3100 in FIFO mode e.g.) you can read an arbitrary amount of data (typically defined by the current value of the FIFO word counter register)in one block transfer from the first address of the FIFO address space. Blocking into smaller blockletts is handled by the hardware without user intervention. This results in optimum VME throughput as minimum setup time is involved.

7.48.2 incrementing VME master

Most VME masters use address auto incrementing on block transfers. The FIFO address space of 8 MBytes is a good compromise for large memories also. The user has to set up several block transfers to read larger portions of memory.

7.49 SDRAM address space (0x800000-0xFFFFFC)

```
#define SIS3820_SDRAM_BASE          0x800000    /* read only; D32/BLTs */
```

For larger memories than 64 MBytes, SDRAM sections (pages) of 64 MBytes are selected with the SDRAM page register.

8 Data Format

The SIS3820 has 4 different data formats. They are defined by the data format bits of the acquisition/operation mode registermode . Non MCS data format is the same as 32-bit MCS. 8 and 16-bit mode were implemented to achieve both lower minimum dwell times and data volume reduction in low count rate/short dwell time environments.

MCS Bit 1	MCS Bit 0	Mode
0	0	32-bit
0	1	24-bit+channel+user
1	0	16-bit
1	1	8-bit

8.1 32-bit Mode

The data word contains the straight scaler contents in this mode.

Bits 31-24	Bits 23-16	Bits 15-8	Bits 7-0
Data Bits 31-24	Data Bits 23-16	Data Bits 15-8	Data Bits 7-0

8.2 24-bit Mode

The lower 24 bits hold the scaler value in this mode, the upper eight data bits contain the latched status of the two user bitss and the bank and channel information. The bit names and their function are listed in the table below.

Bit	Contents
U2	User Bit 2
U1	User Bit 1
0	0
C4	Channel number Bit 4
C3	Channel number Bit 3
C2	Channel number Bit 2
C1	Channel number Bit 1
C0	Channel number Bit 0

Bits 31-24								Bits 23-16	Bits 15-8	Data Bits 7-0
U2	U1	0	C4	C3	C2	C1	C0	Data Bits 23-16	Data Bits 15-8	Data Bits 7-0

8.3 16-bit Mode

The data word contains the straight scaler contents in this mode.

Bits 31-24	Bits 23-16	Bits 15-8	Bits 7-0
Scaler channel N+1 (bits 15-0)		Scaler channel N (bits 15-0)	

8.4 8-bit Mode

The data word contains the straight scaler contents in this mode.

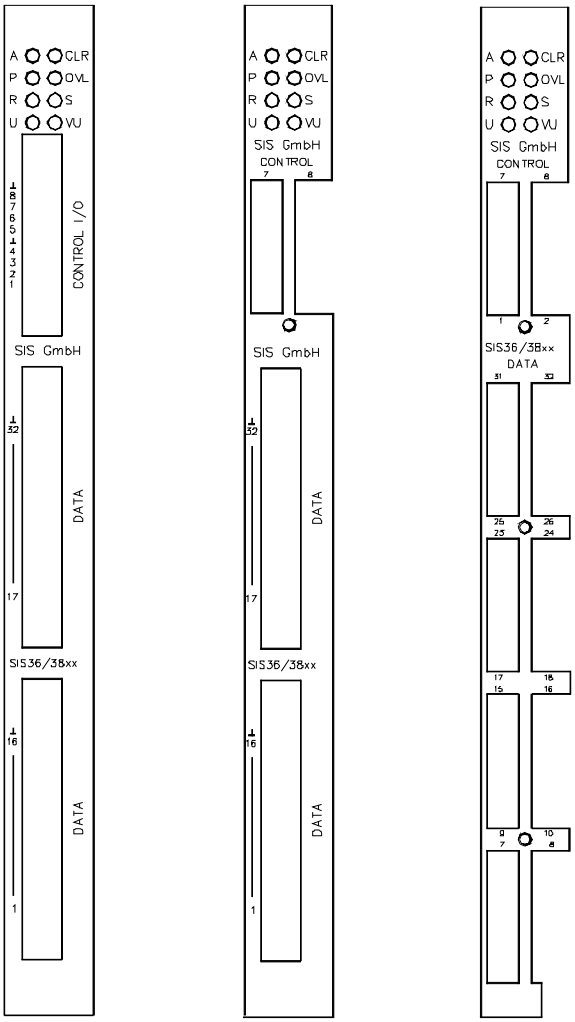
Bits 31-24	Bits 23-16	Bits 15-8	Bits 7-0
Scaler channel N+3 (bits 7-0)	Scaler channel N+2 (bits 7-0)	Scaler channel N+1 (bits 7-0)	Scaler channel N (bits 7-0)

9 Front panel elements

9.1 Front Panel Layout

The front panel of the SIS3820 is equipped with 8 LEDs, 8 control in- and outputs and 32 frontend in/outputs. On flat cable units (ECL and TTL) the control connector is a 20 pin header flat cable connector and the channel inputs are fed via two 34-pin headers. On LEMO (NIM and TTL) units the control in- and outputs are grouped to one 8 channel block and the counter inputs are grouped into 2 blocks of 16 channels. A mixed LEMO control/flat cable counter input version is available also. The units are 4 TE (one VME slot) wide, the front panel is of EMC shielding type. VIPA extractor handles are available on request or can be retrofitted by the user, if he wants to change to a VIPA crate at a later point in time.
In the drawing below you can find the flat cable (left hand side), the LEMO control/flat cable input (middle) and LEMO front panel layouts.

Note: Only the aluminium portion without the extractor handle mounting fixtures is shown

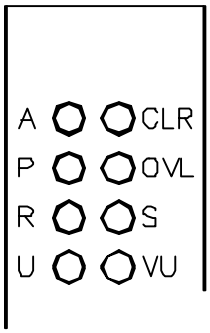


9.2 Front Panel LEDs

The SIS3820 has 8 front panel LEDs to visualize part of the units status. Three LEDs according to the VME64xP standard (Power, Access and Ready) plus 5 additional LEDs (VME user LED, Clear, Overflow, Scaler enable and VIPA user LED).

Designation	LED	Color	Function
A	Access	yellow	Signals VME access to the unit
P	Power	red	Flags presence of VME power
R	Ready	green	Signals configured logic
U	VME user LED	green	To be switched on/off under user program control
CLR	Clear	yellow	MCS mode: signals LNE Latching scaler: signals soft or hardware clear
OVL	Overflow	red	Signals Overflow in one or more channels
S	Scaler Enable	green	Signals one or more enabled channels
VU	VIPA user LED	green	for future use

The LED locations are shown in the portion of the front panel drawing below.



The VME Access, Clear and Scaler enable LEDs are monostable (i.e. the duration of the on phase is stretched for better visibility), the other LEDs reflect the current status.
An LED test cycle is performed upon power up (refer to the chapter 16.6).

9.3 Flat cable Input/Output Pin Assignments

9.3.1 ECL

Data-Connector Channel 1-16

PIN	SIGNAL	SIGNAL	PIN
32	IN16 -	IN16 +	31
30	IN15 -	IN15 +	29
28	IN14 -	IN14+	27
26	IN13 -	IN13 +	25
24	IN12 -	IN12 +	23
22	IN11 -	IN11 +	21
20	IN10 -	IN10 +	19
18	IN9 -	IN9 +	17
16	IN8 -	IN8 +	15
14	IN7 -	IN7 +	13
12	IN6 -	IN6 +	11
10	IN5 -	IN5 +	9
8	IN4 -	IN4 +	7
6	IN3 -	IN3 +	5
4	IN2 -	IN2 +	3
2	IN1 -	IN1 +	1

Front view

INx + = ECL High active
INx - = ECL Low active

Data-Connector Channel 17-32

PIN	SIGNAL	SIGNAL	PIN
32	IN32 -	IN32 +	31
30	IN31 -	IN31 +	29
28	IN30 -	IN30 +	27
26	IN29 -	IN29 +	25
24	IN28 -	IN28 +	23
22	IN27 -	IN27 +	21
20	IN26 -	IN26 +	19
18	IN25 -	IN25 +	17
16	IN24 -	IN24 +	15
14	IN23 -	IN23 +	13
12	IN22 -	IN22 +	11
10	IN21 -	IN21 +	9
8	IN20 -	IN20 +	7
6	IN19 -	IN19 +	5
4	IN18 -	IN18 +	3
2	IN17 -	IN17 +	1

Front view

INx + = ECL High active
INx - = ECL Low active

Control-Connector Input 1-4 /Output 5-8

PIN	SIGNAL	SIGNAL	PIN
20	GND	GND	19
18	OUT8-	OUT8+	17
16	OUT7-	OUT7+	15
14	OUT6-	OUT6+	13
12	OUT5-	OUT5+	11
10	GND	GND	9
8	IN4 -	IN4 +	7
6	IN3 -	IN3 +	5
4	IN2 -	IN2 +	3
2	IN1 -	IN1 +	1

Front view

INx + = ECL High active
INx - = ECL Low active

OUTx + = ECL High active
OUTx - = ECL Low active

9.3.2 TTL

Data-Connector Channel 1-16

PIN	SIGNAL	SIGNAL	PIN
32	IN16 -	GND	31
30	IN15 -	GND	29
28	IN14 -	GND	27
26	IN13 -	GND	25
24	IN12 -	GND	23
22	IN11 -	GND	21
20	IN10 -	GND	19
18	IN9 -	GND	17
16	IN8 -	GND	15
14	IN7 -	GND	13
12	IN6 -	GND	11
10	IN5 -	GND	9
8	IN4 -	GND	7
6	IN3 -	GND	5
4	IN2 -	GND	3
2	IN1 -	GND	1

Front view

INx - = TTL Low active (74F245)

Data-Connector Channel 17-32

PIN	SIGNAL	SIGNAL	PIN
32	IN32 -	GND	31
30	IN31 -	GND	29
28	IN30 -	GND	27
26	IN29 -	GND	25
24	IN28 -	GND	23
22	IN27 -	GND	21
20	IN26 -	GND	19
18	IN25 -	GND	17
16	IN24 -	GND	15
14	IN23 -	GND	13
12	IN22 -	GND	11
10	IN21 -	GND	9
8	IN20 -	GND	7
6	IN19 -	GND	5
4	IN18 -	GND	3
2	IN17 -	GND	1

Front view

INx - = TTL Low active (74F245)

Control-Connector Input 1-4 /Output 5-8

PIN	SIGNAL	SIGNAL	PIN
20	GND	GND	19
18	OUT8-	GND	17
16	OUT7-	GND	15
14	OUT6-	GND	13
12	OUT5-	GND	11
10	GND	GND	9
8	IN4 -	GND	7
6	IN3 -	GND	5
4	IN2 -	GND	3
2	IN1 -	GND	1

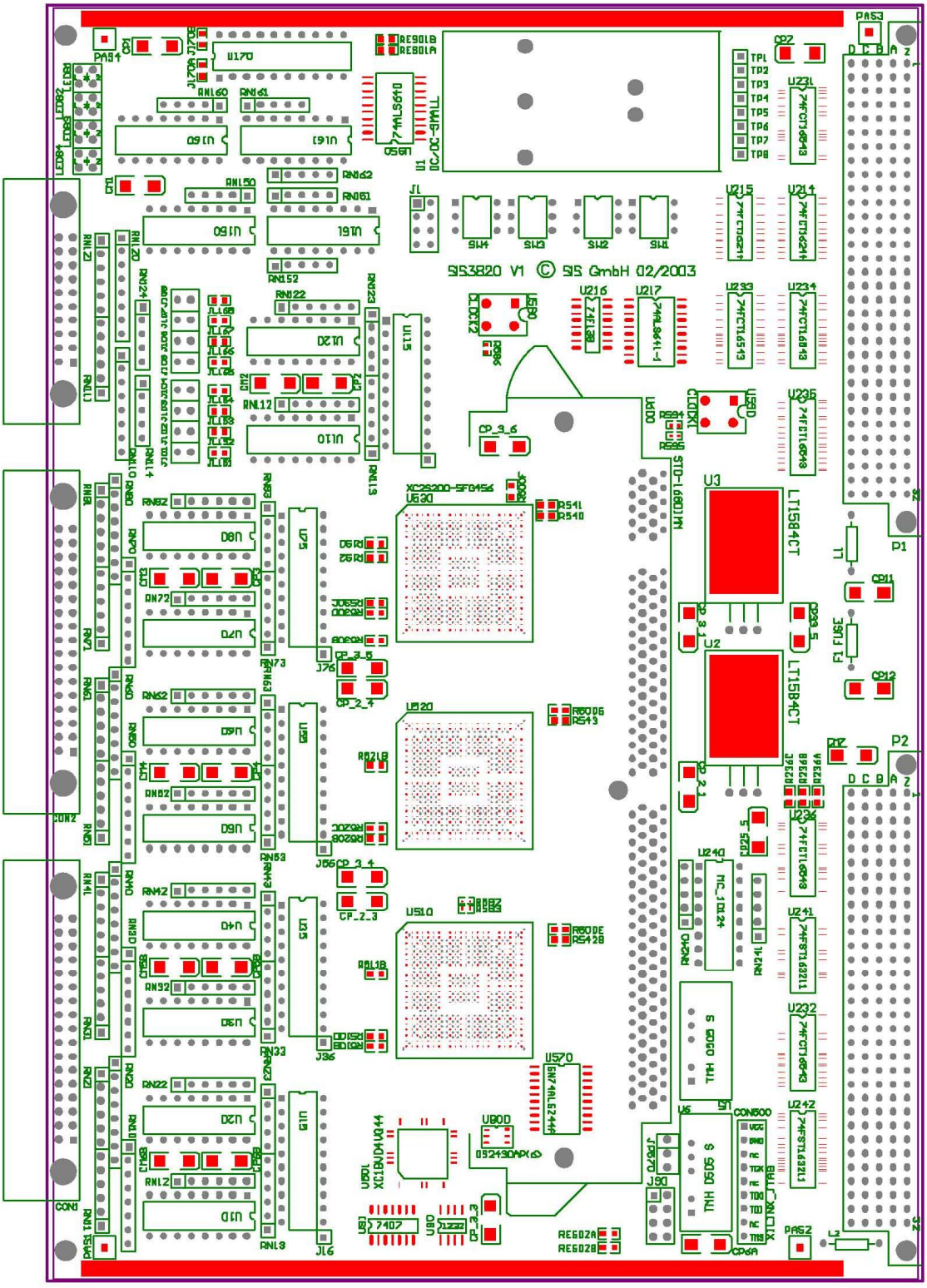
Front view

INx - = TTL Low active (74F245)

OUTx - = TTL Low active (74F244)

10 Board Layout

Find below a printout of the top assembly drawing.



11 Jumper settings/pinouts

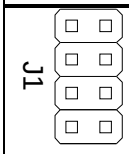
The SIS3820 has 3 jumper fields and a JTAG connector.

Jumper field	Function
J1	VME addressing mode
J90	Reset behavior
JP570	JTAG source
CON500	JTAG connector

The first pin of the jumper fields is marked by a square pin on the solder side and an extra frame on the silk screen of the component side.

11.1 J1

J1 is in charge of the VME addressing mode and SDRAM size selection. At this point in time the user can select between rotary switch selected A32 addressing and geographical A32 addressing.. A closed position selects the corresponding function.

	Function	open	closed
	EN_A32	Disabled	Enabled
	512 MB10/11 COLUMNS	10	11
	EN_GEO	Disabled	Enabled
	SDRAM	64 MB	512 MB

The default setting for a 64 MB unit is EN_A32 closed and all other positions opened.
The 512 MB 10/11 COLUMNS position was reserved up to firmware 0x010D.

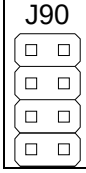
Following memory architectures are supported

Memory size	rows	columns	banks
64 MB	12	9	1
512 MB	13	10	2
512 MB	13	11	1

Note: An example to determine the architecture from the SPD can be found in the Visual C++ example sis3820_sdram_eeprom.c

11.2 J90

J90 controls the reset behavior of the SIS3820.

	Function
	reserved
	connect VME reset to SIS3820 reset
	reserved
	enable watchdog

The default setting is VME reset and enable watchdog closed and all other positions opened.
Note: open the enable watchdog for firmware upgrades

11.3 JP570 JTAG source

Firmware can be loaded to the XC18V04 serial PROM via a JTAG download cable (XILINX JTAG-PC4 e.g.) or via the VME interface of the SIS3830. Please note, that errors during this process can render a module temporarily in non working condition.. JP570 has 3 pins. Depending on whether pins 1 and 2 or 2 and 3 are closed the JTAG source is defined as listed below.

Closed	JTAG source
1-2	JTAG connector CON 500
2-3	VME

Note: shipping default is 1-2 closed (i.e. JTAG over CON500)

11.4 CON500 JTAG

The SIS3820 on board logic can load its firmware from a serial PROMs . The firmware can be upgraded through VME (future option) or the JTAG connector. A list of firmware designs can be found under http://www.struck.de/sis3820firm.htm.
Hardware like the XILINX HW-JTAG-PC in connection with the appropriate software (the XILINX WebPACK is furnished on the accompanying CDROM) will be required for in field JTAG firmware upgrades through the JTAG connector.
The JTAG connector is a 9 pin single row 1/10 inch header, the pin assignment on the connector can be found in the table below.

Pin	Short hand	Description
1	VCC	Supply voltage
2	GND	Ground
3	nc	not connected, cut to avoid polarity mismatch
4	TCK	test clock
5	nc	not connected
6	TDO	test data out
7	TDI	test data in
8	nc	not connected
9	TMS	test modus

Note: close the J90 disable watchdog jumper for firmware upgrades

12 Input Configuration

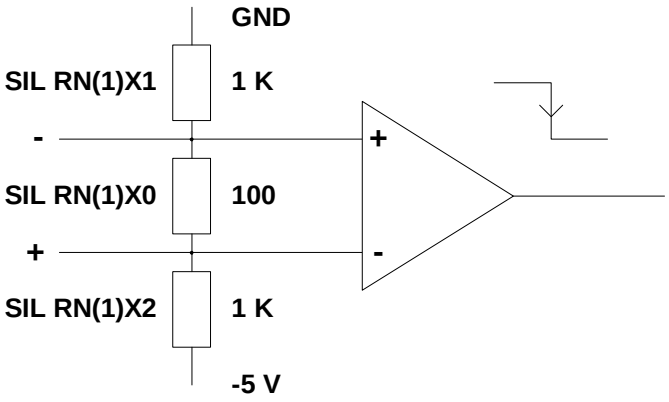
SIS36/38xx boards are available for NIM, TTL , ECL and LVDS input levels and in LEMO and flat cable versions. The boards are factory configured for the specified input level and connector type. Input termination is installed.

12.1 ECL

The 100 Ω input termination can be removed in groups of four channels by removing the corresponding resistor networks. The termination of single control inputs can be disabled with jumpers J101 through J108, an open jumper disables the termination of the corresponding channel.

Network	Channels	1 K Networks
RN10	1-4	RN11/12
RN20	5-8	RN21/22
RN30	9-12	RN31/32
RN40	13-16	RN41/41
RN50	17-20	RN51/52
RN60	21-24	RN61/62
RN70	25-28	RN71/72
RN80	29-32	RN81/82
RN110	Control 1-4	RN111/RN112
RN120	Control 5-8	RN121/RN122

The schematics of the ECL input circuitry is shown below.

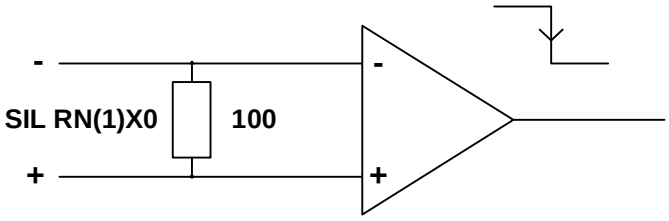


12.2 LVDS

The 100 Ω input termination can be removed in groups of four channels by removing the corresponding resistor networks. The termination of single control inputs can be disabled with jumpers J101 through J108, an open jumper disables the termination of the corresponding channel.

Network	Channels
RN10	1-4
RN20	5-8
RN30	9-12
RN40	13-16
RN50	17-20
RN60	21-24
RN70	25-28
RN80	29-32
RN110	Control 1-4
RN120	Control 5-8

The schematics of the LVDS input circuitry is shown below.

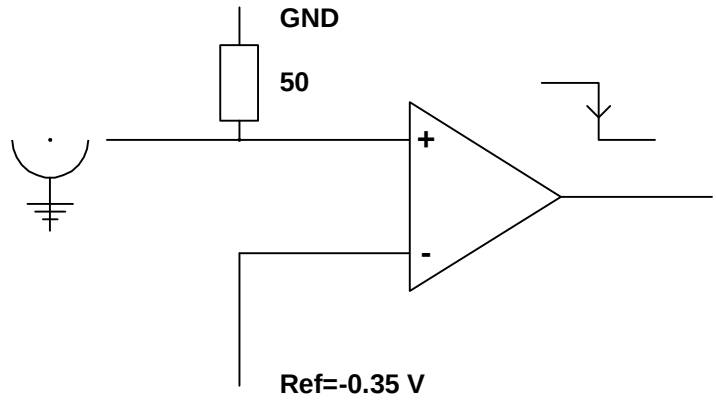


12.3 NIM

The 50 Ω input termination can be removed in groups of four channels by removing the corresponding resistor networks. The termination of single control inputs can be disabled with jumpers J101 through J108, an open jumper disables the termination of the corresponding channel.

Network	Channels
U15 (Pins 10 to 6)	1-4
U15 (Pins 1 to 5)	5-8
U35 (Pins 10 to 6)	9-12
U35(Pins 1 to 5)	13-16
U55 (Pins 10 to 6)	17-20
U55 (Pins 1 to 5)	21-24
U75 (Pins 10 to 6)	25-28
U75 (Pins 1 to 5)	29-32
U115 (Pins 10 to 6)	Control 1-4
U115 (Pins 1 to 5)	Control 5-8

The schematics of the NIM input circuitry is shown below.

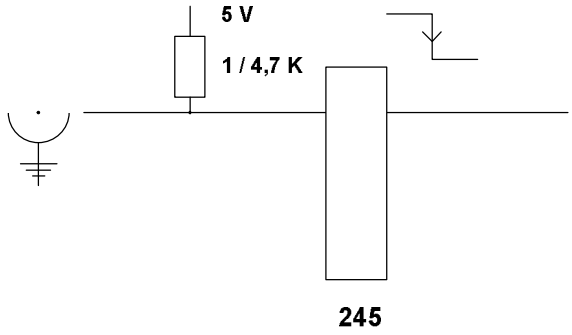


12.4 TTL

The TTL input level option is possible with LEMO and flat cable connectors.

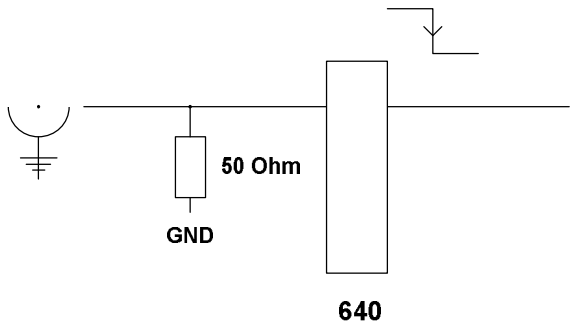
12.4.1 High impedance TTL/LEMO

The (low active) TTL/LEMO input circuitry is sketched below. 1 KΩ and 4,7 KΩ termination are available as options. A high active version can be implemented by replacing the 74F245 with a 74F640



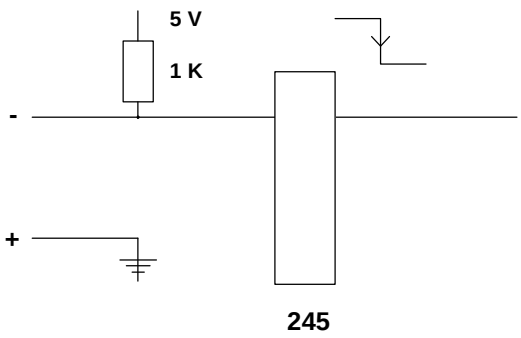
12.4.2 50Ω TTL/LEMO

The (high active) TTL/LEMO 50 Ω input impedance circuitry is shown below.



12.4.3 TTL/Flat Cable

In the flat cable TTL version the positive (right hand side) of the connector is tied to ground.



13 TTL output configuration

Standard TTL units drive high impedance signals (i.e. 24 mA current), a 50 Ω driver piggy (driving 48 mA) pack is installed on 50 Ω TTL units. It plugs into the socket U170 instead of the standard driver chip.

14 Signal Specification

14.1 Control Signals

The width of clear and external next pulses has to be greater or equal 10 ns, an external inhibit (disable counting) has to be present for the period you desire to disable counting. An internal delay of some 15 ns has to be taken into account for all external signals.

14.2 Inputs

The SIS3820 is specified for counting rates of 250 MHz for ECL and NIM signals and 100 MHz for the TTL case. Thus the minimum high and low level duration is 2.0 ns (5 ns respective). Signal deterioration over long cables has to be taken into account.

14.3 User Bits

The status of the user bits is latched with the leading edge of the external LNE pulse. A setup time of greater equal 10 ns and a hold time of 25 ns is required, i.e. the signal should have a length of greater 35 ns and has to be valid 10 ns before the leading edge of the LNE pulse arrives. User bit information is pipelined, i.e. the information that is stored with the scaler values was recorded at the beginning of the counting period.

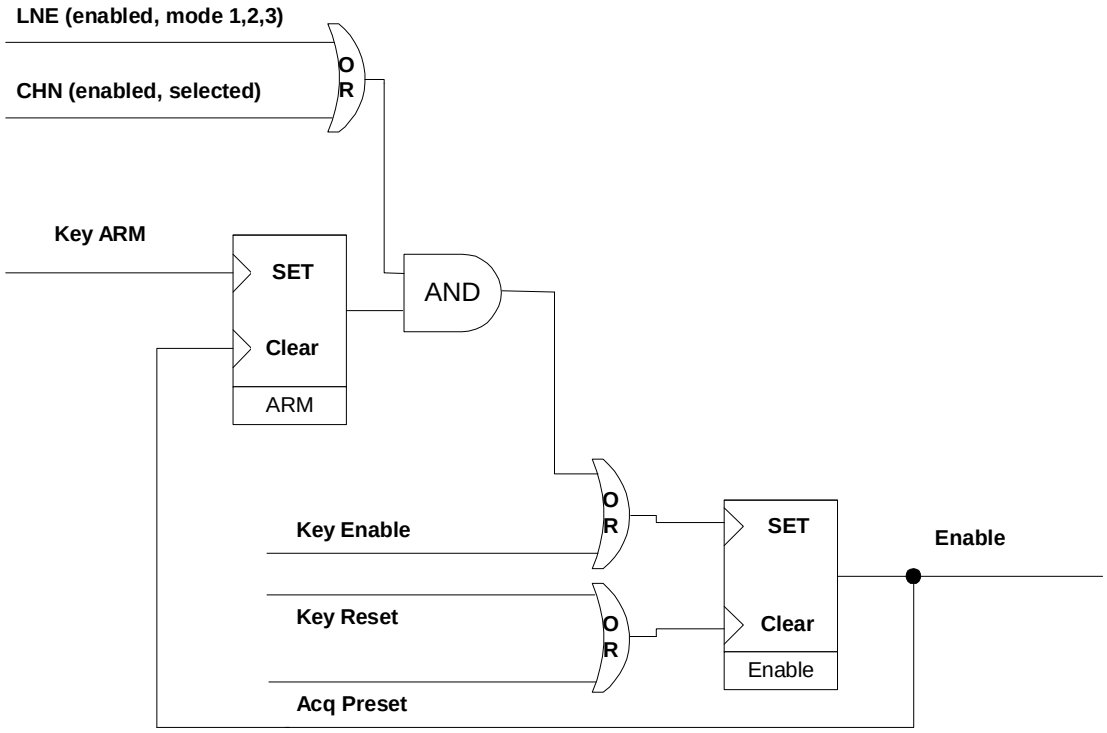
14.4 LNE Output Timing

The leading edge of the LED output occurs 60-80 ns after the leading edge of the LNE input/signal. I.e. a 60-80ns module to module delay results from a LNE daisy chain. A LNE fanout or direct routing of the LNE signal (input termination on intermediate modules to be removed) can be used in case more accurate synchronous operation of several SIS3820's is desired.

15 Theory of operation

15.1 Enable Logic

The logic of the SIS3820 is disabled by default upon power up of the module (due to the execution of a key reset). In a standard counter application a key enable command is all that is required to enable the logic, in MCS or preset mode other signals like arm and LNE are contributing as shown in the enable logic schematic below.
The enable logic should not be mixed with the counter enable/disable for the individual channels.



15.2 Read on the fly

The SIS3820 supports read on the fly (i.e. readout in parallel to the acquisition of new counts) with an accuracy down to the lowest bit at the full counting rate of 200 MHz. While the uncertainty on a read on the fly is one count no counts are lost. A read from a counter register of the SIS3820 initiates a clock shadow transaction and the actual counter value that is read from VME is taken from the shadow register. The counter values of all 32 scaler channels are latched to the shadow registers simultaneously when the read on the fly is done in BLT32. Minimum difference in time (i.e. less than 5 ns variation) of the read values can be achieved with this mechanism.

15.3 Latching scaler

Counter data can be copied to the shadow registers in three ways

- Key VME LNE/clock shadow
- external next pulse LNE/clock shadow with input modes 1, 2 and 3
- read from the counter registers

Shadow register data are not altered/updated in the normal counting process, i.e. the latched values can be re/read until they are overwritten by the next clock shadow cycle.

15.4 Preset Scaling

In preset mode the counting mode is started by an enable command and stopped by a channel reaching the preset value of counts. The preset reached state can be used as interrupt source. As an alternative you can poll on the preset reached bit in the preset enable and hit register to check on the occurrence of the preset reached condition.. Preset scaling can be used as LNE source in multi channel scaling (channel N mode) also.
It will take in the order of 100 ns after the preset condition was detected before the counters will stop counting. This implies, that the actual stored counter value will be greater than the preset value for frequencies in excess of some 10 MHz.

15.5 Multiscaling (MCS)

Multi channel or multiscaling is a method to decouple the realtime behavior of fast counting processes from the VME readout process. Data are buffered in an onboard memory and readout at a later point in time in an asynchronous fashion. The SIS3820 uses standard 168-pin SDRAM memory strips as buffer, the default size is 64 MBytes. The memory can be used in:

- SDRAM mode
- FIFO mode

While SDRAM mode fits applications with a known number of acquisition cycles that will fit into the SDRAM strip completely, FIFO mode allows for the sustained acquisition of measurements of an arbitrary number of readout cycles under the assumption, that the VME master is capable of digesting the generated data rate. The time slices (or load next event=LNE cycles) can be defined by following processes:

- VME LNE
- external LNE signal
- internal 10 MHz pulse generator
- channel N as preset scaler

The later three can be routed through a prescaler.

15.5.1 Minimum dwell time

Find below a table with minimum dwell times for a number of configurations.

Number of channels	Channel depth (bits)	Dwell time in ns
32	32	960
16	32	500
8	32	340
32	16	660
16	16	340
8	16	260
32	8	500
16	8	260
8	8	220

Please note that a depth of 8 bits (i.e. 0-255 counts) is by far sufficient to hold all counts that can occur at the maximum count rate and minimum dwell time. The minimum dwell time for a given configuration can be measured on the CIP output (with output mode 1 and 2).

15.5.2 arm/enable with MCS

15.5.2.1 enable

Use the key operation enable command for multiscaling with an internal time base (prescaled internal 10 MHz pulse generator e.g. like in the sis3820_mcs example program). The first time slice (counting period) will have the same length as consecutive slices this way.

15.5.2.2 arm

Use the key operation arm command for multiscaling with an external time base (LNE source). By means of the arm/enable source bits of the operation mode register you can define whether the actual enable will be defined by the LNE front panel signal (with input mode 1,2 or 3 active) or the ChN source. This way your first time slice/counting period will have the same lengths (angular encoder clock ticks, stepper motor ticks, ...) as consecutive bins.

15.6 Clearing/non clearing mode

The SIS3820 has two sets of counters. The two sets are the actual counters and the „old counters“. Both counter sets are preset to 0 after a power up/key reset or counter clear.
The actual counter set becomes active with the count enable.

At LNE (or read shadow) following process is initiated depending on the non clearing mode bit of the acquisition/operation mode register

“non clearing mode” = 0 :

- the contents of the current counter set is subtracted from the contents of the “old counter” set (which was latched by the previous LNE/clock shadow) and the difference is stored in the shadow register set or copied to SDRAM/FIFO
- the contents of the current counter set is stored to the “old counter” set

“non clearing mode” = 1 :

- the contents of the current counter set is stored to the shadow register set or copied to SDRAM/FIFO

15.7 Histogramming Scaler (HISCAL)

Histogramming scalers are typically used for repetitive low count rate applications. While the VME master has to readout the data across the VME bus in MCS mode, counts from consecutive scans are added up on board the SIS3820 in HISCAL operation.
HISCAL operation is the combination of MCS mode with SDRAM add mode. The HISCAL_START signal is used in addition to the MCS setup. The HISCAL_START signal (from VME or as a front panel input, as defined with the HISCAL_START_SOURCE_BIT of the operation mode register) resets the memory pointer to the beginning of the histogram (until the HISCAL_START_PRESET value is reached or HISCAL operation is disabled.
Refer to the 3 histogramming scaler Visual C++ examples to get started.

15.7.1 Minimum dwell time in HISCAL mode

Find below a table with minimum dwell times for 2 configurations in HISCAL mode.

Number of channels	Channel depth (bits)	Dwell time in ns
32	32	4000
...	...	...
4	32	500

Note: High word count block transfer access to the SDRAM in parallel to MCS/HISCAL acquisition can result in an increased worst case minimum dwell time of some 8 µs.

15.8 Firmware upgrade over VME

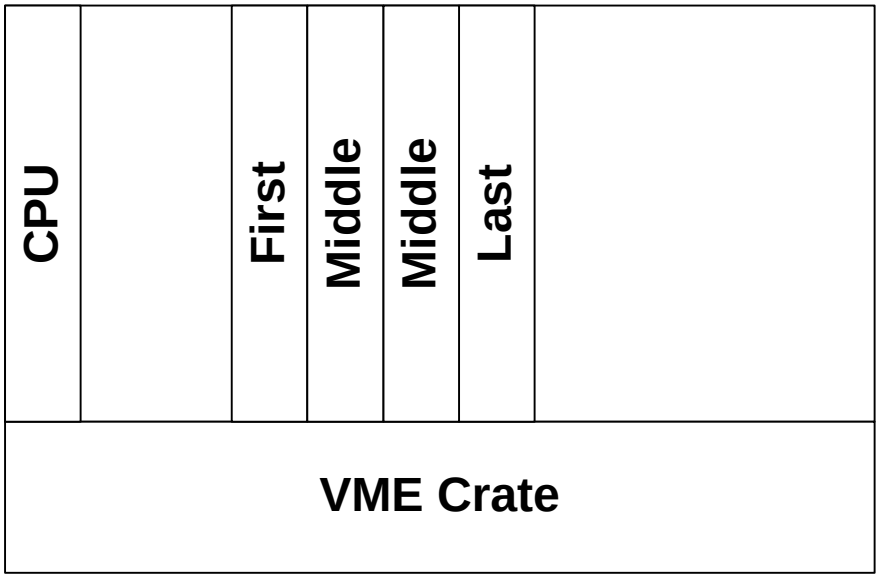
SIS3820 units at firmware greater or equal 0102 support firmware upgrade over the VME bus. The VME to JTAG interface is implemented through the JTAG_TEST/JTAG_DATA_IN and the JTAG_CONTROL registers. Refer to the documentation for the XILINX XC18V04 serial PROM for operation details.
The LINUX and Visual C++ sis3820_jtag_prom.c code on the CDROM allows you to upgrade the firmware of your SIS3820 in combination with the SIS1100/3100 PCI to VME interface or to port the code to your VME environment.

Note 1: select the proper JP570 jumper setting to activate JTAG over VME

Note 2: A SIS3820 module may be rendered in non working condition after an error in the firmware download sequence. Operation/proper firmware has to be re-established with a JTAG firmware download cable in that case.

15.9 CBLT readout (3820 01 03 and higher design)

CBLT is a method to speed up the readout of small amounts of data from a larger number of slaves in conjunction with long setup time masters. As header and trailer words are added in CBLT, this readout approach is less efficient than low setup overhead list sequencer readout of masters like the SIS3100 VME sequencer.
Modules which are supposed to participate in a CBLT have to get the same CBLT address, in the case of the SIS3820 the CBLT address is defined by the upper 8 bits of the CBLT setup register . The module closest to the CPU has to be defined as “First” CBLT module, the module at the end of the chain is defined as “Last” CBLT module. All modules have to have their CBLT enable bit set, the modules must occupy a contiguous set of VME slots as shown in the sketch below. The token is passed from the previous module to the next module via the IRQ daisy chain lines as soon as all data have been read. The last module in the chain terminates the transfer with a VME bus error (BERR). .



Schematic CBLT setup

The SIS3820 supports the CBLT readout mode only in the MCS (Multiscaler) mode in FIFO mode !

15.9.1 CBLT Setup example

Assume four SIS3820 (as shown in the crate above) are supposed to participate in a CBLT. The modules are set to D32 addressing and VME base address configuration as shown in the table below. 0x45 is used as CBLT address and the CBLT setup registers of the four modules are configured as shown in the list.

Module number	D32 base address	VME slot	CBLT setup register	Comment
1	0x20000000	11	0x45200805	First, Geo 1, max. 32 words, CBLT enable
2	0x21000000	12	0x45201001	CBLT enable, Geo 2, max. 32 words
4	0x22000000	13	0x45201801	CBLT enable, Geo 3, max. 32 words
4	0x23000000	14	0x45202003	Last, Geo 4, max. 32 words, CBLT enable

0x**45**200805: CBLT address is 0x45xxxxxx
0x45**20**0805: CBLT Max. Readout Length is 32 (0x20) D32 words (0x80 bytes)
0x4520**08**05: CBLT Geo address is 1
0x45200**805**: CBLT is enabled and First module in chain

A BLT32 read from VME address 0x45000000 will result in a CBLT over the 4 modules, with the selected geographical addresses showing up in the header and trailer words.

32-bit data word	Content	Comment
1	0x08000000	Header module 1, Geo 1
2	Value ch. 1, module 1	
..	..	
33	Value ch. 32, module 1	
34	0x08000088	Trailer module 1, 0x88 Bytes
35	0x10000000	Header module 2, Geo 2
36	Value ch. 1, module 2	
..	..	
67	Value ch. 32, module 2	
68	0x10000088	Trailer module 2, 0x88 Bytes
69	0x18000000	Header module 3, Geo 3
70	Value ch. 1, module 3	
..	..	
101	Value ch. 32, module 3	
102	0x18000088	Trailer module 3, 0x88 Bytes
103	0x20000000	Header module 4, Geo 4
104	Value ch. 1, module 4	
..	..	
135	Value ch. 32, module 4	
136	0x21000088	Trailer module 4, 0x88 Bytes, Status: Last module (bit 24)

If the modules contain no scaler data (FIFO is empty), the resulting VME data will look like shown below.

32-bit data word	Content	Comment
1	0x08000000	Header module 1, Geo 1
2	0x08000008	Trailer module 1, 8 Bytes
3	0x10000000	Header module 2, Geo 2
4	0x10000008	Trailer module 2, 8 Bytes
5	0x18000000	Header module 3, Geo 3
6	0x18000008	Trailer module 3, 8 Bytes
7	0x20000000	Header module 4, Geo 4
8	0x21000008	Trailer module 4, Status: Last module, 8 Bytes

15.9.2 CBLT hints

While it is trivial to setup a block of modules for CBLT readout, one has to be aware of specialities of this readout form.

- The user has to make sure, that the read access to the CBLT address is a BLT32 block transfer (with address modifier AM=0xB or AM=0xF), i.e. the modules will not respond to a read, which is broken down into many single reads (AM 0x9 e.g.). This can be verified with a VME diagnosis module like the VDIS or with an oscilloscope and an extender.

- The requested number of bytes of the CBLT transfer have to be higher than the max. number of bytes of the readout data of all participated modules. This ensures that the Last module terminates the CBLT transfer with a BERR* signal. All other participated modules monitor a BERR* occurring and then they terminate the CBLT transfer. All modules are now ready for the next event.

- In many cases the block size will not be known, as it may depend on the number of hits in an ADC or TDC. In that case the user will have to setup a CBLT with the number of possible words and rely on the capability of a block transfer terminated by a VME bus error and a returned Byte count to indicate the actual length of the transfer.

15.10 Broadcast

Broadcast is a way to distribute a signal like LNE with minimum jitter and latency to a number of SIS3820 units over VME. Broadcast uses the same setup as CBLT. Broadcast addressing uses the CBLT address plus the offset of the given key address to invoke the corresponding action. An example will be made available shortly.

16 Appendix

16.1 P2 row A/C pin assignments

The P2 connector of the SIS3820 (in 64 channel or clock module configuration) has connections on rows A and C to feed the second set of 32 inputs to the module or for operation as backplane clock distributor for the SIS330x digitizer family. This implies, that the module can not be operated in a VME slot with a special A/C backplane, like VSB e.g.. The pin assignments of P2 rows A/C of the SIS3820 for both scaler and clock module is shown below. 32 channel versions do not make use of P2 rows A/C.

P2A	Scaler Function	Clock Function	P2C	Scaler Function	Clock Function
1	not connected	-5.2 V	1	not connected	-5.2 V
2	not connected	-5.2 V	2	not connected	-5.2 V
3	not connected	-5.2 V	3	not connected	-5.2 V
4	not connected	not connected	4	not connected	not connected
5	not connected	not connected	5	not connected	not connected
6	DGND	DGND	6	DGND	DGND
7	Control 1	P2_CLOCK_H	7	Control 0	P2_CLOCK_L
8	DGND	DGND	8	DGND	DGND
9	Control 3	P2_START_H	9	Control 2	P2_START_L
10	Control 5	P2_STOP_H	10	Control 4	P2_STOP_L
11	Control 7	P2_TEST_H	11	Control 6	P2_TEST_L
12	DGND	DGND	12	DGND	DGND
13	DGND	DGND	13	DGND	DGND
14	G34_L16	not connected	14	G34_L15	not connected
15	G34_L14	not connected	15	G34_L13	not connected
16	G34_L12	not connected	16	G34_L12	not connected
17	G34_L10	not connected	17	G34_L9	not connected
18	G34_L8	not connected	18	G34_L7	not connected
19	G34_L6	not connected	19	G34_L5	not connected
20	G34_L4	not connected	20	G34_L3	not connected
21	G34_L2	not connected	21	G34_L1	not connected
22	DGND	DGND	22	DGND	DGND
23	G12_L16	not connected	23	G12_L15	not connected
24	G12_L14	not connected	24	G12_L13	not connected
25	G12_L12	not connected	25	G12_L11	not connected
26	G12_L10	not connected	26	G12_L9	not connected
27	G12_L8	not connected	27	G12_L7	not connected
28	G12_L6	not connected	28	G12_L5	not connected
29	G12_L4	not connected	29	G12_L3	not connected
30	G12_L2	not connected	30	G12_L1	not connected
31	DGND	DGND	31	DGND	DGND
32	not connected	not connected	32	not connected	not connected

16.2 Row d and z Pin Assignments

The SIS3820 is ready for the use with VME64x and VME64xP backplanes. Features include geographical addressing (PCB revisions V2 and higher) and live insertion (hot swap). The used pins on the d and z rows of the P1 and P2 connectors are listed below.

Position	P1/J1		P2/J2	
	Row z	Row d	Row z	Row d
1		VPC (1)		
2	GND	GND (1)	GND	
3				
4	GND		GND	
5				
6	GND		GND	
7				
8	GND		GND	
9		GAP*		
10	GND	GA0*	GND	
11	RESP*	GA1*		
12	GND		GND	
13		GA2*		
14	GND		GND	
15		GA3*		
16	GND		GND	
17		GA4*		
18	GND		GND	
19				
20	GND		GND	
21				
22	GND		GND	
23				
24	GND		GND	
25				
26	GND		GND	
27				
28	GND		GND	
29				
30	GND		GND	
31		GND (1)		GND (1)
32	GND	VPC (1)	GND	VPC (1)

Note: Pins designated with (1) are so called MFBL (mate first-break last) pins on the installed 160 pin connectors, VPC(1) pins are connected via inductors.

16.3 Connector Types

Find below a list of connector types that are used on the SIS3820.

Connector	Purpose	Part Number
160 pin zabcd	VME P1/P2	Harting 02 01 160 2101
20 pin header	Control (flat cable versions)	DIN41651 20 Pin (AMP e.g.)
34 pin header	Inputs (flat cable versions)	DIN41651 34 Pin (AMP e.g.)
LEMO	Control and Input (LEMO versions)	LEMO ERN.00.250.CTL
SDRAM	SDRAM memory socket	Berg 88638-60002

16.4 Power consumption

The SIS3820 is a single +5 V supply board. Lower positive voltages (3.3 V and 2.5 V) are generated with low dropout regulators. –5 V is generated with up to 3 DC/DC converters.

Board type	Voltage	Current
SIS3820-SCALER (32 ECL channels)	5 V	2,0 A
SIS3820-SCALER (32 TTL channels	5 V	1,3 A
SIS3820-CLOCK (32 NIM channels)	5 V	3,2 A

16.5 Operating conditions

16.5.1 Cooling

Although the SIS3820 is mainly a 2.5 and 3.3 V low power design, forced air flow is required for the operation of the board. The board may be operated in a non condensing environment at ambient temperatures between 10° and 40° Celsius.

16.5.2 Hot swap/live insertion

Please note, that the VME standard does not support hot swap by default. The SIS3820 is configured for hot swap in conjunction with a VME64x backplane. In non VME64x backplane environments the crate has to be powered down for module insertion and removal.

16.6 LED (selftest)

During power up self test and FPGA configuration all LEDs except the Ready (R) LED are on. After the initialization phase is completed, all LEDs except the Ready (R) LED and the Power (P) have to go off. Differing behavior indicates either a problem with the download of the firmware boot file or one or more FPGAs and/or the download logic.

16.7 VME readout performance

A SIS3820 can generate in excess of 128 MBytes/s worth of data (at the minimum dwell time with 32 channels active in 32-bit mode) in principle. A more realistic data rate in the short dwell time regime is 64 MBytes/s, as 8-bits counter depth will be sufficient to hold the maximum possible number of counts. The VME interface was optimized with respect to the block transfer readout of this possible substantial amount of data. Find below a table of block transfer speeds of the SIS1100/3100 PCI to VME interface on readout of data from the SDRAM of the SIS3820. The measurements were made with 40 longword blocks (the speed was computed by dividing the number of bytes be the difference of the leading edge of the first DS1 and the trailing edge of the last DS1).

Mode	Transfer speed
BLT32	25 MB/s
MBLT64	50 MB/s
2e VME	88 MB/s

Note: you have to be aware, that the typical setup time for a block transfer is in the 25 µs ballpark. I.e. you will want to read out large blocks of data in high speed applications to minimize overhead.

16.8 Software Support

The SIS3820 board comes with the sis3820.h header file that defines register offsets as well as relevant bit addresses within the registers. This header file should facilitate SIS3820 software development for all platforms.
C example code for the SIS3820 is provided for both Visual C++ and LINUX. The code was written to be used with the SIS1100/3100 PCI to VME interface, but should be readily portable to other environments.
A Windows Labview interface is available for the SIS3150 USB2.0 to VME interface.

17 Glossary

Following shorthands/expressions are used throughout the manual

Term	Explanation
ChN	Channel N as LNE source
CIP	Copy in progress (data are copied from the frontend FPGA registers to memory registers on the VME FPGA)
Clock Shadow	Initiate copy process of frontend scaler data to register set
FPGA	Field Programmable Gate Array
HISCAL	Histogramming Scaler
KA	Key address. Write access with arbitrary data to a key address initiates the specified function
LNE	Load Next Event. Initiate next counting period, save data from previous counting period.
MCS	Multi Channel Scaler

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